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LEANDRO MARQUES QUEIROS

DESIGNING GROUPWARE FOR COLLABORATIVE LESSON PLANNING FOR BASIC EDUCATION TEACHERS

Recife
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DESIGNING GROUPWARE FOR COLLABORATIVE LESSON PLANNING FOR BASIC EDUCATION TEACHERS

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I dedicate this thesis to my mother Maria de Fátima Marques da Silva and my father Guido Fernandes Queiros.

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ABSTRACT

Collaborative lesson planning among basic education (K-12) teachers encourages experience and educational resource sharing. Those practices are distributed in time and space and vary as professionals evolve their experiences. Teachers creatively improvise the functions of mundane and digital artifacts to accomplish circumstantial objectives that emerge in collaborative professional practice. In this thesis, we use a digital ethnography approach to deeply understand the social experience of collaborative lesson planning and build knowledge about these phenomena. We adopt the anthropological notions of improvisation and contingency to understand how creatively basic education teachers collaborate while preparing classes. We conducted sequences of unstructured interviews in the workplace (schools and homes) and virtually reenacted observations. All collected data were analyzed to evidence the situated meanings of materials, relationships, and circumstances of these idiosyncratic procedures among professionals. The main results evidence some improvisations and contingencies in sharing experiences and how artifacts directly structure practices and experiences, leading to frustration, dissatisfaction, and, consequently, helplessness. We present specific recommendations for the design of teachers' collaborative lesson planning support systems. Thus, we performed a situated participatory design that allowed teachers to visualize themselves in possible future scenarios, using groupware to support their collaborative classroom preparation practices. The results indicate that carrying out collaborative lesson planning activities in a class planning groupware designed from a participatory design with elementary school teachers is a successful approach, as it allows the design of significant artificial artifacts for teachers and promotes well-being related to the domains of affect, community, and work.

Keywords: teacher collaboration; teacher well-being; participatory design; basic education.

RESUMO

O planejamento colaborativo de aulas entre professores da educação básica incentiva o compartilhamento de experiências e recursos educacionais. Essas práticas estão distribuídas no tempo e no espaço e variam à medida que os profissionais evoluem suas experiências. Os professores improvisam criativamente as funções de artefatos mundanos e digitais para atingir objetivos circunstanciais que emergem na prática profissional colaborativa. Nesta tese, usamos uma abordagem de etnografia digital para entender profundamente a experiência social do planejamento colaborativo de aulas e construir conhecimento sobre esse fenômeno. Adotamos as noções antropológicas de improvisação e contingência para entender como os professores da educação básica colaboram criativamente no planejamento das aulas. Realizamos sequências de entrevistas não estruturadas no local de trabalho (escolas e residências) e virtualmente reencenamos observações. Todos os dados coletados foram analisados para evidenciar os significados situados dos materiais, relações e circunstâncias desses procedimentos idiossincráticos entre os profissionais. Os principais resultados evidenciam alguns improvisos e contingências no compartilhamento de experiências e como os artefatos estruturam diretamente práticas e experiências, além de identificação em alguns casos de frustração, insatisfação e, consequentemente, desamparo. Apresentamos recomendações específicas para o design de sistemas de apoio ao planejamento de aulas colaborativas de professores. Assim, realizamos um design participativo situado que permitiu que os professores se visualizassem em possíveis cenários futuros, usando sistema colaborativo para apoiar suas práticas colaborativas de preparação em sala de aula. Os resultados indicam que a realização de atividades colaborativas de planejamento elaborada a partir de um design participativo com professores do ensino fundamental é uma abordagem bem-sucedida, pois permite o design de artefatos artificiais significativos para os professores e promove o bem-estar relacionado aos domínios de afeto, comunidade e trabalho.

Palavras-chave: colaboração dos professores; bem-estar do professor; design participativo; educação básica.

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LIST OF ABBREVIATIONS AND ACRONYMS

BNCC	Common National Curriculum Base
CA	Correspondence Analysis
CBIE	Brazilian Congress of Informatics in Education
CGI.br	Brazilian Internet Management Committee
CLP	Collaborative Lesson Planning
CSCW	Computer Supported Cooperative Work
DICT	Digital Information and Communication Technologies
Dim	Dimension
GDR	Groupware Design Recommendations
GRE	Regional Education Management
INEP	Anísio Teixeira National Institute of Educational Studies and Research
INPI	National Institute of Industrial Property
LD	Learning Design
LP	Lesson Planning
MEC	Ministry of Education in Brazil
PCA	Principal Component Analysis
PPP	Political-Pedagogical Project
SIEPE	Education Department of the State of Pernambuco's Information System

CONTENTS

1 INTRODUCTION

This chapter reports the motivations for carrying out this thesis, the justification, the research question, the research objectives, and finally, it shows how the rest of this thesis is structured.

1.1 MOTIVATION

The practice of collaborative lesson planning (CLP) is a voluntary activity between teachers and others, an opportunity to share purposes, resources, and responsibilities by a mutual decision-making method (FRIEND; COOK, 2016; BADAWI, 2017). Planning is an essential practice for pedagogical development. In the universe of learning, teachers deal with the details of technical, political, and social aspects of education (NGUYEN; BOWER, 2018; SEBASTIÃO DOS SANTOS, 2019).

When teachers collectively work on practical problems, they will likely better meet students' needs (DARLING-HAMMOND, 2010; CRAVENS; HUNTER, 2021). Currently, planning is essential for incorporating digital technologies in teaching 21st-century students (GIANNAKOS et al., 2018). When designing, teachers can invent by creating something new, innovate by setting things up in a new way, and reuse an artifact (MOR; CRAFT; HERNÁNDEZ-LEO, 2013).

According to Simon (1996), engineers are not the only professional designers: "Everyone designs who devises courses of action aimed at changing existing situations into preferred ones." (SIMON, 1996, p. 111).

Learning design (LD) serves as the basis for teacher and student development, generating an effective teaching and learning cycle (APARECIDA et al., 2008; Sudirman, 2017).

In carrying out CLP, teachers must consider several crucial components of teaching-learning strategies. These would be such as knowing one's personality as a teacher, knowing one's own and others' social and cultural contexts, acknowledging the most appropriate methodology for the characteristics of the subjects, assessment, and teaching resources, among other components (APARECIDA et al., 2008; Sudirman, 2017).

The CLP involves various school stakeholders' relationships (students and their families, teachers, supervisory staff, and school management). The mediation of these

actors further increases the teacher's responsibility to perform effective planning (THOMAZI; ASINELLI, 2009). Thus, planning activity contributes to the teachers' work and students' learning efficiency and is essential to ensure that the classes' objectives are fulfilled (SAAD et al., 2014).

Hence, CLP activities are social phenomena that consistently develop educational practice. During the last decade, the interest in teachers' proficiency in collaborating to perform their work successfully, aiming to delegate tasks between people, emerged as a study niche (VANGRIEKEN et al., 2015). Social and technical aspects are predominant in Computer Supported Cooperative Work (CSCW) (IQBAL et al., 2005). The social analysis of activities aims to understand the nature of cooperative work in order to lay a foundation for guiding the design of support information systems. The technical aspects reflect peoples' working practices in developing a system (CARSTENSEN; CARSTENSEN, 1999; IQBAL et al., 2005).

Inside the literature on teachers' lesson planning (LP), there is consistent agreement on the relevance of teachers' planning activities and their impact on students' performance. The demands imposed by 21st-century education systems require changes in responding to society's needs, including a perspective that will comprehend social and economic changes (SOSA; MANZUOLI, 2019).

In many countries, where communities face hard local realities, students perform at lower levels than expected (WORLD BANK, 2019). National education systems with low levels of student performance deserve attention. In Brazil, according to the latest census released by the Anísio Teixeira National Institute of Educational Studies and Research (INEP), it is possible to verify that there has been no positive development in relation to the goals set by the Ministry of Education in Brazil (MEC). In this country, the performance of high school students has not reached the goals set out and has been stagnant for many years (BRASIL, 2019). Planning lessons can allow teaching professionals to reach effective results with clarity and autonomy, experience self-efficacy and fulfill their wishes (OLIVEIRA, 2019).

Planning allows for better performance on tasks. It is considered relevant with respect to our limited cognitive capacity, easing the burden of processing imposed by multiple tasks (BALEGHIZADEH; SHAHRI, 2017).

However, even though planning is paramount for quality teaching and learning, some teachers do not perform planning efficiently. The professional may neglect or improvise carelessly, resulting in the non-achievement of founding objectives for

student education (BAKKENES et al., 1999; OSTOVAR-NAMEGHI; SHEIKHAHMADI, 2016; WOODLAND; MAZUR, 2018). An ethnographic approach seems necessary to understand more profoundly the essential meanings of practices for participants in order to inspire considerations for likely digital futures.

Another factor that limits lesson planning activity is the time available. According to a Brazilian Internet Management Committee (CGI.Br) survey, 60% of teachers work 31 hours or more during the week (BRASIL, 2022). Few hours are dedicated to lesson planning activities. The numbers show that lesson planning occupies 27.5% to 55% of the total time worked at schools, whether the total hours of work amount to 20 or 40 hours. On top of this, 74% of Brazilian teachers in urban schools feel pressured or lack time to comply with the expected content (BRASIL, 2018). Therefore, the number of hours spent at school is not enough for teaching work to be fully accomplished.

There are many problems related to CLP. Firstly, there is the lack of time, leading to teacher stress; and furthermore, lack of support in share lesson plans with fellow teachers (BAKKENES et al., 1999; VANGRIEKEN et al., 2015) resulting in a culture of isolation for lesson planning (PATTON; PARKER, 2017; ROSSITTO, 2018), impacting the well-being (WEILAND, 2021). Some empirical works reveal difficulties reported by teachers concerning isolation at work and lack of collaboration. Hurdles also include difficulty in adapting course work and incompatibility between systems, lack of the required proficiency in technologies or programming languages to manipulate tools, obstacles in usability to access tools, and lack of spaces to share ideas, needs, or solutions for concerns (CHACON; HERNÁNDEZ-LEO, 2014; TADJINE et al., 2016; ASENSIO-PÉREZ et al., 2017).

The present thesis contributes to filling the gaps in knowledge for the research question: **How can the adoption of a collaborative system conceived in a continuous co-design process promote teachers' well-being when used in collaborative lesson planning?** This more in-depth understanding is necessary to guide the system design and serve as a CLP activity tool (ANDERSON, 1994; REDTENDBACHER, 2004; VASSÃO, 2019).

1.2 OBJECTIVES

This thesis aims to study the phenomenon of collaborative lesson planning among teachers in relation to lesson planning activity. The aim is to build knowledge around the structure of the collaborative work of basic education (K-12) teachers. This

knowledge will guide the co-creation of groupware[1] that makes teaching practice more effective, particularly for collaborative practices in lesson planning. Therefore, the general objective of this research is to **propose recommendations for the design of groupware that enhances the collaborative activity of lesson planning**.

1.2.1 Specific Objectives

To achieve the general objective, these specific objectives were defined:

- Comprehend the activities carried out in the collaborative lesson planning by teachers of basic education.
- Elaborate participatory design of a mediating system for collaborative lesson planning activities.
- Evaluate teacher's well-being perceptions in a groupware prototype that supports knowledge sharing activities and educational resources as a collaborative mechanism for lesson planning.

1.3 RESEARCH ROAD MAP

The thesis is based on a paper-based thesis, presented through three studies in an integrated format (KUBOTA et al., 2021). This research assumes design research (DR) through practice as a method (KOSKINEN et al., 2011). We combine qualitative and quantitative approaches (FLICK, 2013; SUMARTOJO; PINK, 2017). DR adds to the appropriation of knowledge and the performance of scientific research, as it allows for the advancement of research based on multidisciplinary and transdisciplinary knowledge and is linked to the purpose of solving relevant and necessary problems through the proposition of an artificial (designed) artifact (HEVNER; CHATTERJEE, 2010).

In addition, the projective design paradigm is adopted, introducing concepts of reduction, which corresponds to the deconstruction of the existing challenge or solution. The structure of the problem is analyzed through other paradigms. In addition,

[1] FUKS, Hugo et al. Do modelo de colaboração 3c à engenharia de groupware. Simpósio Brasileiro de Sistemas Multimídia e Web–Webmidia, p. 0-8, 2003.

objectives are specified to look for orientations on improvement. The appropriate paradigms are examined to achieve the objectives defined by the research.

The second phase corresponds to Selection. The paradigms are explored and evaluated through multiple alternatives to choose paradigms for application to meet the specific requirements of Wake research (2000). The third phase is Application, in which the chosen paradigms are incorporated into ideation and concept generation. If the researcher deems it necessary, at this stage the combination of more than one can occur. Finally, the fourth phase, called the Test, aims to verify if the design is following the goals and considerations defined by the project (YILDIRIM, 2014).

1.4 BIBLIOGRAPHICAL PRODUCTION AND INNOVATION

This section aims to disseminate the scientific results obtained and innovative actions. All publications contributed to the definition, understanding, and evolution of this thesis.

Published papers:

- QUEIROS, Leandro et al. Context Analysis of Teachers' Learning Design Practice Through Activity Theory, Distributed Cognition, and Situated Cognition. In: International Workshop on Learning Technology for Education in Cloud. Springer, Cham, p. 247-259, 2019.
- QUEIROS, Leandro et al. The adoption of learning experience design tools in classroom planning activity: A systematic literature review. In: Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality, p. 704-710, 2019.
- QUEIROS, Leandro et al.Collaborative Strategies for Professional Development of High School Teac hers: Groupware Co-Design for Learning Experience Design. In: Anais do II Workshop on Advanced Virtual Environments and Education. SBC, p. 9-12, 2019.
- QUEIROS, Leandro et al. Lessons planning instrumental genesis: between teachers? instrument systems and professional development. In: EARLI SIG 14 Learning and Professional Development conference, 2018, Genebra. Proceedgins of the EARLI SIG 14 Learning and Professional Development conference, p. 1-6., 2018.

- QUEIROS, Leandro et al. Usability Testing for Teachers' Lesson Planning Services. In: 2018 IEEE Frontiers in Education Conference (FIE). IEEE, p. 1-8, 2018.

Also, participation in a doctoral symposium and workshop.

- QUEIROS, Leandro; GOMES, Alex. Co-design de Groupware para Planejamento entre Professores do Ensino Médio. In: Anais do Workshop de Desafios da Computação Aplicada à Educação. p. 54-55, 2019.
- QUEIROS, Leandro et al. Collaborative Strategies for Professional Development of High School Teachers: Groupware Co-Design for Learning Experience Design. In: Anais do II Workshop on Advanced Virtual Environments and Education. SBC, p. 9-12, 2019.
- QUEIROS, Leandro et al. Learning experiences design: Integration of e-learning environments. In: 2017 12th Iberian Conference on Information Systems and Technologies (CISTI). IEEE, p. 1-4, 2017.

During the doctoral studies, some participation in events contributed to the development of the research and the researcher. He participated in the first Residency program in Entrepreneurship in Digital Business (SandPIT) at CIn/UFPE in 2018. The participation had the collaboration of Alex Sandro Gomes, Carlos José and Júlio Toscano, with the Inovaula.com project. The project went through the incubation process, receiving infrastructure, advice, training, networking, tools, and adequate solutions for the development of startups. The project generated interest from co-investors through the mediation of CESAR.Labs, where presentations and negotiations took place.

Considering the above participations, a Certificate of Registration of Computer Programs, titled Inovaula, was issued by the National Institute of Industrial Property (INPI), under case number: 51 2018 001158-6, issued on 12 July 2018. Also, he supported Professor Alex Sandro Gomes in co-orientation of students of the Institutional Program of Scientific Initiation Scholarships and course conclusion works.

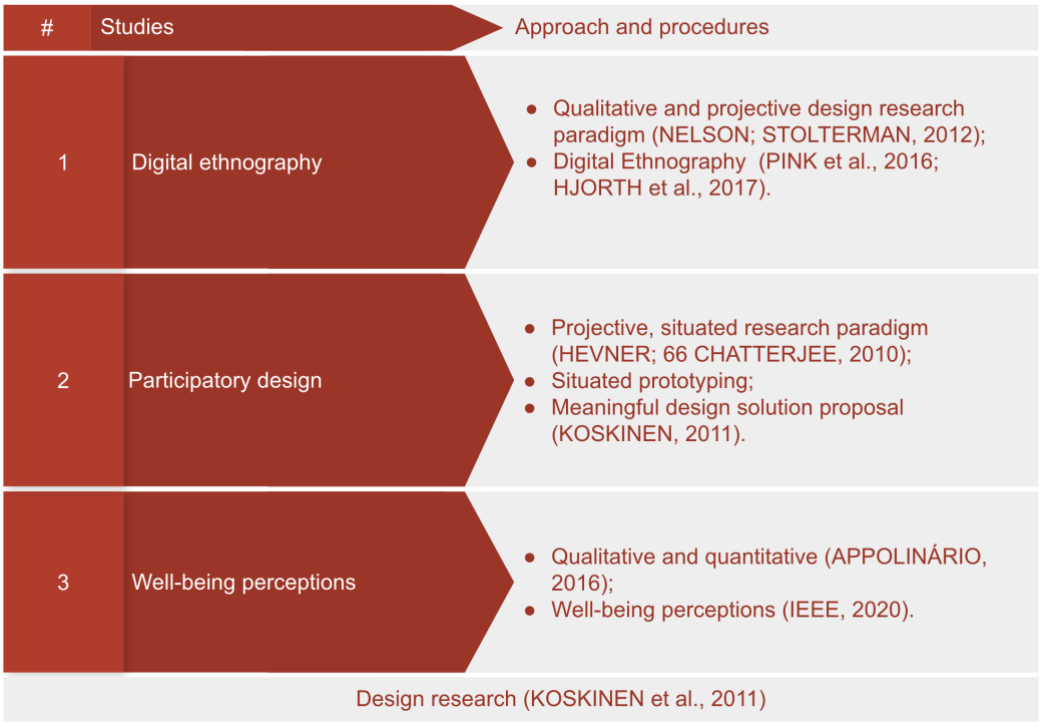
He was an organizer of the Integrated Contest for the Development of Technology Solutions and Learning Objects for Education (Apps.edu), which took place at the Brazilian Congress of Informatics in Education (CBIE) in 2021. The contest aims to

diagnose real problems that affect education in Brazil. And propose ideas and technological solutions for educational progress and digital entrepreneurship, encouraging the participation of researchers, teachers, students, government representatives, entrepreneurs, and non-governmental institutions in an integrated ecosystem that combines science, innovation, and entrepreneurship towards quality education.

1.5 THESIS OUTLINE

This chapter is a Summary article linking the other studies of this Thesis. The remainder of this Thesis is divided into 3 studies, according the respective method (Figure 1). Each part consists of a previously submitted article about technology to enhance learning and digital ethnography.

Figure 1 - Method – Approach and procedures



Source: The author (2022).

Study I: Collaborative lesson planning among teachers encourages the sharing of experience and educational resources. These practices are distributed over time and space, varying as professionals evolve in their professional experiences. In this study, we used a digital ethnography approach to deeply understand the social

experience of collaborative lesson planning, building knowledge about these phenomena. We adopted the anthropological notions of improvisation and contingency to understand how creatively high school teachers collaborate while preparing classes. We conducted sequences of unstructured interviews in the workplace (schools and homes) and virtually (online), and by reenactments and observations. All collected data were analyzed to demonstrate the situated meanings of materials, relationships, and the circumstances where these idiosyncratic procedures occur among professionals. The main results reveal some kinds of improvisations and contingencies in sharing experience and show how undesigned artifacts directly structure practices and experiences, leading to frustration, dissatisfaction, and, consequently, helplessness. Teachers creatively improvise the functions of mundane and digital artifacts to accomplish circumstantial objectives that emerge in collaborative professional practice. We unveil and specify recommendations for the design of teachers' support systems for collaborative lesson planning.

Study II: Collaboration allows teachers to interact with regularity, specificity, and depth in order to create new dynamics and understandings on teaching. Teachers orchestrate the central elements surrounding the goals that need to be achieved for classroom performance, the objectives, and the purpose of the lesson plan. The current study uses design prototyping procedures and techniques to amplify the manner in which these professionals approach lesson planning. Dialectically, this in-depth understanding, using multiple methods of participatory design, has guided us to evolve the design of a computational tool to support professional lesson planning and to speculate on future digital possibilities for this practice. Situated participatory design has made it possible for teachers to visualize themselves in possible future scenarios, using groupware as a tool that is able to support their collaborative classroom preparation practices.

Study III: The availability of Digital Information and Communication Technologies (DICT) in education has become fundamental in developing digital skills and promoting teachers' well-being. When effectively adopted, it enhances planned pedagogical practices. However, the use of DICT in classrooms is unique to each teacher's context, mainly due to teachers' DICT training needs for DICT mastery and low levels of collaboration between teachers. How can collaborative lesson plan groupware impact teacher well-being? The answer to this question can contribute to the literature as it will inform the level of well-being of these professionals perceived in groupware that

supports their craft, especially lesson planning activities. We adopted a projective research paradigm. This research is qualitative and quantitative. We used quantitative data generated from the survey responses applied to the participants. Qualitative data were generated from thinking aloud when using the proposed groupware. The results indicate that carrying out collaborative lesson planning activities in a class planning groupware prototype designed from a participatory design with basic education school (K-12) teachers is a perceived approach. Furthermore, it allows the design of significant artificial artifacts for teachers and promotes well-being related to the domains of community, affect and work.

1.6 CONTRIBUTIONS AND CONCLUSIONS

Below are the main contributions and conclusions of this thesis:

I. Study I: The digital ethnography of lesson planning practice and framework for CLP. This knowledge and evidences contribute to the advancement of the CLP literature and can be the basis for studies and groupware development.

II. Study I: Four validated Groupware Design Recommendations (GDR)

- GDR1: Collaborative systems c the capture of lived experience over time so that educators may record and collect resources, memories, ideas, and reports of practices. Should stimulate de action-reflection-action. In addition, it should allow for the insertion of what should be done soon, including collaborative outlooks;
- GDR2: Groupware could support the teacher and anticipate teaching situations. The system could support planning with contingencies that cannot be foreseen. Groupware should help teachers to deal with unknown events, feelings, and emotions.
- GDR3: Collaborative systems must allow for unstructured and non-hierarchical collaboration, supporting unpredictability, experiences, and time management, encouraging creativity and innovation. Moreover, together with other people, cooperation may promote collaborative creativity, brought about by multiple experiences and inclinations towards different themes;

- GDR4: Collaborative systems must present content and data that inspire teachers. It is expected that it allows teachers to have results as expected and recognize their professional growth. This also concerns the growth of their students. Personalization may be permitted, as it is a motivating element of pedagogical practice. However, innovation must be promoted to impact the physical and digital structure, the relationships with teaching-learning, and interpersonal communication.

III. Study II and III: Teachers realized that they felt they belonged to a community and could be helped by it, and did not feel rejected by the teacher community when carrying out groupware lesson planning activities. Adopting groupware can promote the perception of calm and happiness in teachers. The teachers' perception is that using groupware would increase productivity and job satisfaction.

IV. Study III: The applied techniques allowed the identification of behavioral patterns of individuals from the multivariate dataset. In domains of affect, community and work, a, there is a pattern, such as the identification of outliers and similarities between the multivariate measures of the individuals. Such results may allow a better understanding of the impact of groupware on teachers' well-being.

1.7 LIMITATIONS OF THE STUDY AND FUTURE WORKS

We present the following limitations of this work:

- The groupware was not published in a production environment. Participants used a high-fidelity prototype. Despite presenting a graphical interface to what must be developed, there are limitations of interaction via clicks on the pages, scroll movements and some pages had a flow of clicks to perform the test activity;

- The exploratory technique adopts, in principle, cannot explore variables of the domain's well-being (affects, community, and work) in database that not be of this study.

Future work can be performed from this research. Some possibilities will be described below.

- Analyze teachers who teach at other levels of education and work in other regions of the country. It can be realized from task analysis and digital ethnography;
- Use an inferential method to indicate the number of groups, such as logistic regression, multilayer neural networks in knowledge sharing and reuse of digital educational resources. The results can contribute to the understanding of teacher profiles;
- Analyze knowledge sharing and reuse of digital educational resources in the context of using groupware. It can be analyzed from discourse analysis. The results can contribute to the understanding of the construction of knowledge among teachers;
- Evaluate groupware design recommendations with experts (designer, software engineer, software developer, HCI researcher, and others); You can evaluate from expert opinion. The results can contribute to the evolution of groupware;
- Develop and publish the proposed groupware in a production environment. The goal is to make it available to the target audience.

2 UNPREDICTABILITY IN UNSTRUCTURED AND NON-SEQUENTIAL TEACHERS' LESSON PLANNING PRACTICES: RECOMMENDATIONS FOR SYSTEMS DESIGN

2.1 INTRODUCITON

2.1.1 Teachers' Lesson Planning Practices

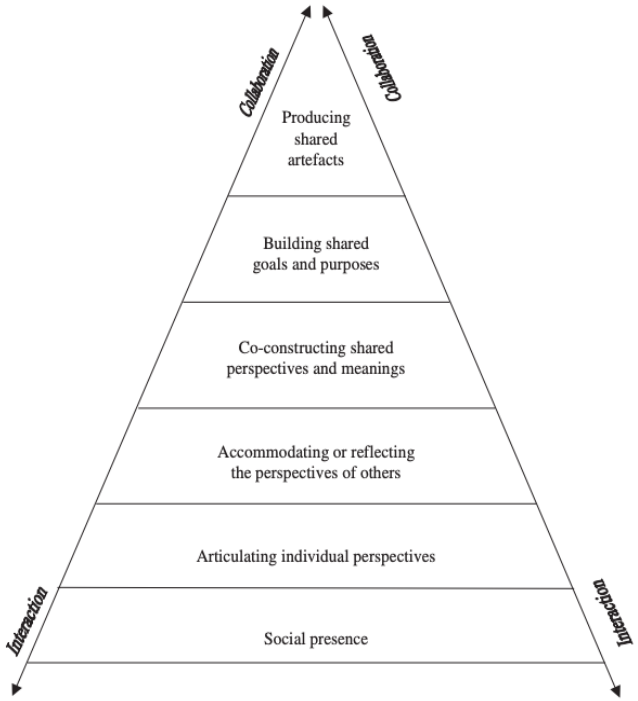
Considering the entire teaching process is considered, the lesson planning of classes becomes the starting point and the basis of teaching, an essential step in determining the quality of education (COPPOLA, SCRICCA, CONNORS, 2004; LIU; ZOU, 2014; KOBERSTEIN-SCHWARZ; MEISERT, 2022). Clark and Yinger (1979) described planning as the invisible and lonely part of teaching. Those conditions influence the quality of the planning process and the educational results (JALONGO et al., 2008). Often, the lesson planning activity starts with difficulties and limitations. The practice of distancing by experienced teachers gives beginners the eerie feeling of being the first and only ones to map the territory. Milkova (2020) reports that an adequate plan should provide an overall aspect of teaching objectives, learning objectives, and the means to achieve them.

According Jalongo et al., (2008), there is no systemic willingness on the part of experienced teachers to share what they know. Apparently, there is limited desire to stimulate the learning process for new teachers. Isolation also affects experienced teachers, who may regret that they have never had a chance to call upon observations about what they are doing. Teachers may be reluctant to share their best work to discuss their shortcomings in a culture that rewards individuals. In the words of a registered professional: “I did a lot of work on this project, and my grade-level group never does anything creative. Why should I give them all of my work to copy?” (JALONGO et al., 2008, p. 50). Teachers are blockaded from answers to questions they need answers for; as well as opportunities to expand on study of their subject and further develop experience regarding content for students (FLINDERS, 1988). Thus, isolation is seen as a problem in a professional learning process that limits access to new ideas and external values (FULLAN; HARGREAVES, 2000).

Murph (2004) proposes a six-level progressive development model of collaboration between teachers. As collaboration progresses through levels, the activities evolve from interaction to collaboration as social presence, until attaining the

optimum shared artifacts level (see Figure 2). At the first level, social presence, participants are aware of each other's presence and begin to relate as a group, thereby emerging group cohesion. Teachers start to articulate individual perspectives at the second level, but as monologues. They only observe the presence of others, but do not explicitly refer to their perspectives or solicit feedback from them. At the third level, teachers begin to accommodate and reflect on their perspectives. Participants are open to each other's points of view. This level is a prerequisite for collaborative knowledge and new meanings building. When co-constructing shared perspectives and meanings at the fourth level, participants can restructure their thoughts due to questioning, evaluating, and analyzing perspectives, beliefs, and assumptions. This corroborates with O'Malley (1995), who affirmed that when an individual's perspective is challenged, the person must work together with others to produce shared purposes. The fifth level represents the moment when participants start building shared objectives and purposes. They come to have common goals. Common sense emerges between them, and then they begin to move in unison in a prevailing direction. Eventually, all the results presented previously would imply the production of a shared value in adding artifacts. When the highest level is attained, planned artifacts are created and students and teachers start learning from each other (MURPHY, 2004).

Figure 2 - Murphy's collaboration model



Source: MURPHY, 2004.

In addition to teaching classes, teachers' routines include other responsibilities, and the following can be highlighted: planning and execution of didactic work according to the school curriculum and, eventually, considering the progression of educational technology; survey and interpretation of data about the reality of their classes; acting collaboratively in the school environment, participating in meetings, class council, civic participation, among other requests from the school board (CLARK; YINGER, 1979; SAMPAIO; MARIN, 2004). Teachers need many hours to complete their planning activities, obliging these professionals to continue carrying out tasks at home (SANTOS, 2016). Thus, the quality or performance of these activities may limit teaching-learning.

As a consequence of recent developments, teachers have engaged in various pedagogical practices related to information and communication technologies, thus embracing new professional approaches. In the next section, we address teaching practices that lead to feelings of isolation and analyze the functions of tools that measure collaboration between teachers.

The present study deepens the knowledge about CLP activities carried out by basic level school teachers. It seeks to build knowledge about the nature of the work they engage in. The paper is organized as follows: Subsection 2.1.2 reviews work related to teachers' cooperative work lesson

planning and presents structured and known obstacles. In Section 2.2, we describe the methodological approach, data collection, and analysis procedures. The main results are presented in Section 2.3, where we highlight evidence of the main findings. Finally, in Section 2.4, we discuss highlights, implications, limitations of this study, and suggestions for the design of effective collaborative work systems.

2.1.2 Teachers' Collaborative and Individual Lesson Planning

The literature has discussed this topic since the last century, and it is highlighted in many discussions about educational change and teacher development (MOREIRA, 1997; BAKKENES et al., 1999; SPILLANE; SHIRRELL, 2018).

Collaboration among teachers is crucial, as teaching practice is a social and most human activity (NIAS, 1998). Collaboration allows teachers to interact with more regularity, specificity, and depth to create new understandings and dynamics under the banner of teaching (HORN; LITTLE, 2010; YEH et al., 2021).

Lesson planning, individually, causes a sense of professional isolation, resulting in negative impacts on daily teaching and ongoing development, especially for young teachers (YUAN et al., 2018). A limited cognitive approach is perceived when teachers do not collaborate adequately at work, either quantitatively or qualitatively (PEPPLAU; PERLMAN, 1982). Individual work has become structurally and culturally incorporated into the work of teachers (VANGRIEKEN et al., 2015). For García (2010), the isolation of teachers is favored by the architecture of the school, where they are organized into independent modules, the distribution of time and space, professional capacities and privacy exists in relation to peers.

There are two sets of conditions to comprehend isolation as a condition that teachers experience. The first and most common set are the features of the work environment where the teacher would interact with colleagues and circumstantial aspects; the lack of them produces feelings of isolation. The second sets of conditions involve the psychological domain and the absence of orientation to deal with working circumstances. The second orientation locates the workplace within the individual, as it is created and recreated using information filtering and processing (FLINDERS, 1988).

The first definition is a kind of collaborative lesson preparation. According to Badawi (2017), collaborative lesson preparation rests on the concept of collaboration, as defined by Friend & Cook (2016). They define this specific collaboration as a voluntary engagement between teachers when they share goals, resources, and responsibility in a mutual decision-making process. This innovation can include students as part of this activity to contribute to teachers' development (STANOVICH, 1996). The collaborative activities to prepare classes include sharing, reflecting, writing, implementing procedures and engaging in peer coaching (GUTIEREZ, 2021). As a result of the experience, professionals can construct functional and high-quality lesson plan activities (BADAWI, 2017).

A second definition for CLP activity associates it with effective planning, considering it "an essential element of good teaching and promoting student achievement" (JALONGO et al., 2008, p. 43). Following the authors, the lesson planning process has a huge impact. Its influence is observed in short-term and long-term planning and provides a framework for selecting purposes and developing activities and assignments that connect, expand, and extent identified knowledge,

skills, and attitudes. It also includes the appropriate prescriptions of learning assessments.

Teachers must prepare and teach classes, carry out administrative and educational activities, and participate in professional development events. These events consume much time in relation to workload, to the point that there is often a lack of time to carry out all scheduled activities.

The needs for collaboration and available time to surpass feelings of isolation, and the impacts of obstacles for the effectiveness of teaching practice, highlight the complexity of collective teaching professional practice and continuous improvement.

In the next section, we present the Design Ethnography approach employed to understand the meanings of users' CLP practices.

2.2 METHOD

We study collaborative lesson planning activities carried out by basic education public school teachers. Appropriate approaches and techniques were used to understand the complexity between the above factors, including the participants' creation of meaning and speculation on better answers for situated ethnographies (PINK et al., 2016; HJORTH et al., 2017). We sought to build knowledge about the nature of CLP activities. Following Pink & Mackley (2015), we engage in this approach to capture teachers' intentions while preparing for adverse scenarios and co-design future solutions for their professional development. The epistemological reference to phenomenology, emphasizing how participants experienced and reported the phenomenon, in their affinity with the objective (the act is done or said) and subjective phenomena (emotions, unobservable emotions, and sensations) (HUSSERL, 1990), had the purpose of creating understanding of the fundamental questions of the objective of this research, as a primary and structuring foundation.

Ethnography is often used to allow capturing the social and technical aspects for which the activities are being developed (ANDERSON, 1994; IQBAL et al., 2005; ROBINSON et al., 2007). In this study, we adopted digital ethnography[2] practices to understand CLP findings, propose design insights and guide the development of a

[2] "Digital ethnography explores the consequences of the presence of digital media in shaping the techniques and processes through which we practice ethnography, and accounts for how the digital, methodological, practical and theoretical dimensions of ethnographic research are increasingly intertwined" (PINK et al., 2015).

collaborative system for this activity (PINK et al., 2016). It is a qualitative and projective design research paradigm (NELSON; STOLTERMAN, 2012) that encompasses existing challenges or a deconstruction of possible solutions. We adopted design ethnography to capture subjective aspects of experiences, whether through experiences (what people feel); practices (what people do); things (the objects that are part of our lives); relationships (our intimate social environments); social worlds (the groups and other social configurations through which people relate); localities (the very popular contexts we inhabit); and events (the union of various things in public contexts). Those categories are general enough in order not to bias our interpretation and let us explore the meanings of practices for participants (PINK et al., 2016).

We consider that teachers act as designers when they adapt knowledge and artifacts to accomplish their planning creatively. We adopted the anthropological notion of creative improvisation (INGOLD; HALLAM, 2021) to understand the improvisations created by teachers to face situational constraints. In so doing, we assume that artifacts emerge and are designed by teachers in situations for educational purposes, paying special attention to the way they creatively solve contingencies. The interpretation of improvisation phenomena allows us to identify essential activities of teachers and can guide the proposition of solutions for the problems inherent to CLP activities.

2.2.1 Participants

For the study, there were inclusion criteria: a. a teacher with three or more years of teaching experience in high school; b. teacher in ongoing service at a public high school; c. willingness to participate in the research voluntarily (see Table 1). We assign fictitious names to each participant to protect their identities. The following exclusion criteria were defined: a. participants who remained unwilling to sign the consent form; b. respondents who either deliberately provided false answers or did not respond to more than half of the survey items. In the sampling process, we asked fellow researchers if they knew teachers who met the inclusion and exclusion requirements. Eight participants were selected.

Table 1 - Profiles of participating teachers

Participants	Academic Education	Teaching Time (years)	Age (years)	Environment
(PE1) Interviewed Participant 1 - José	Mathematics	Between 5 and 9	21 to 29	Virtually. The participant was at his home.
(PE2) Interviewed Participant 2 - Ana	Biology	Between 5 and 9	30 to 39	Virtually. The participant was at her mother-in-law's house.
(PE3) Interviewed Participant 3 - Francisco	Mathematics	Between 5 and 9	30 to 39	Virtually. The participant was at his home.
(PE4) Interviewed Participant 4 - Amanda	Biology	10 years or more	30 to 39	Teachers' room at school.
(PE5) Interviewed Participant 5 - Felipe	Physics	10 years or more	30 to 39	Teachers' room at school.
(PE6) Interviewed Participant 6 - Bruna	Physical Education	10 years or more	50 to 60	Teachers' room at school.
(PE7) Interviewed Participant 7 - Luana	Geography	Between 5 and 9	30 to 39	Teachers' room at school.
(PE8) Interviewed Participant 8 - Maria	Mathematics	Between 5 and 9	40 to 49	Teachers' room at school.

Source: The author (2022).

The researchers made requests via WhatsApp® messages. They asked their colleagues if they would like to collaborate in the research, answering a semi-structured interview, on an agreed day and at a time convenient for the interviewee.

All participants were appointed by the school management, except teachers PE1, PE2, and PE3, who were nominated by the researcher's colleagues; these interviews were conducted online, via Google Meet.

2.2.2 Data Collection

Semi-structured and narrative interviews were conducted to understand how creatively high school teachers collaborate while preparing classes, at school and virtually. The questions included were (CAEIRO-RODRÍGUEZ et al., 2016): 1) What are the preparations usually done just before the start of a class? 2) What resources are part of these preparations? 3) How do these resources influence preparations? 4) Do you plan individually or in cooperation/collaboration with other teachers? 5) Do you follow some kind of guideline, for example, provided by your administration? Do you use some kind of software to support the planning? 6) Do you use any main document as a reference to plan? 7) What elements do you consider in planning, such as student features, available resources, and needs for other subjects? 8) At what level of detail do you elaborate your lesson plan, distinguishing between very little detail or a huge level of detail. 9) What types of resources do you include in the lesson plan? The following options are offered: textbooks, text documents, multimedia, software applications, electronic devices, materials invited to class, visits to sites outside the school, etc. 10) Do you include ICT activities for your students? 11) Do you share lesson plans publicly (distinguishing if they do this with other teachers), yet within the educational center, or more openly with anybody interested?

Interviews were held between April 2018 and April 2020. For each meeting, we organized the interaction as follows: (a) Participants were welcomed, completion of Consent Form, and Test Introduction: the research project and its objectives were presented. Then, the Informed Consent Form was declared to determine participation in the study. Once the terms were agreed upon, the data collection started; (b) A semi-structured interview was carried out to collect demographic data from the participants; (c) Narrative interviews were carried out to collect data from the participants' experiences; (d) Reenactment of the activity: participants were asked to explain how they would act, as well as to reenact significant episodes for the object of study. Also, we conducted a non-participant observation (MARCONI; LAKATOS, 2017). All procedures performed in studies involving human participants were in compliance with

ethical standards. All interviews were carried out in Portuguese (PT-Brazil) and translated to English.

2.2.3 Data Analysis and Interpretation

We adopted the definition of scenario as "a relationship between active people and the areas relating to which they act." (LAVE, 1988). In this sense, we consider situated actions as "the activity of people who act in a unit of analysis", and the length of analysis is the relation between the person and the setting (Ibid.).

All audio and video data were transcribed using the transcribe tool and analyzed using the ATLAS.ti software. The categories were created by the researchers who authored this study. These emerged from the analysis and reflection carried out from the collected data (MERRIAM, 2015), including immersion of the researchers in the field context.

The unit of analysis of this study was the activity. The researcher interacts with the data using content analysis (BARDIN, 2011) with the aim of the researcher to immerse themselves once again with data. We followed the methodological criteria that were considered for this kind of data analysis (BARDIN, 2011): (1) Clear rules for inclusion and exclusion in categories; (2) The categories must be mutually exclusive (exclusivity); (3) The categories cannot be extensive. Or: that they do not put different things in the same bag (Homogeneity); (4) the categories must include all possible content, and "other" must be residual (exhaustiveness); (5) Objectivity, without subjectivism ("reliability"); and (6): It means verifying that the documentary source adequately corresponds to the analysis (Relevance). By the end, thematic narratives were produced as a third manner of data interaction. Those narratives aim to represent aspects of the complexity of collaborative lesson planning activities.

2.3 RESULTS: EVERYDAY COLLABORATIVE LESSON PLANNING

In this section, we present eight thematic narratives (Table 2) to synthesize how CLP practices are carried out and making sense of physical and digital artifacts. The narratives are inspired from content analysis. The themes are: (a) physical work environment, (b) planning and plans, (c) individual and collective practices, (d) well-

being, (e) lack of time, (f) improvisation, (g) knowledge and resources, and (h) information systems.

Table 2 - The eight themes generated from content analysis

Theme	Definition	Representativeness	Keywords that originated this theme
Physical work environment	A place where the teacher performs lesson plannig activities.	All participants presented reports of experiences for this category, except participant PE6.	School, home, GRE (Regional Education Management)[3], activity, class, teachers, planning, time, Internet, books, and flash drive.
Planning and plans	The set of planning at different levels. These are the government level (annual), semiannual, bimonthly, weekly, and daily.	All participants presented reports of experiences for this theme.	Day, daily, annual, planning, teaching, preparing, bimonthly, and semester. Additionally, this category is backed by a pedagogical approach to teaching, that is, the 'teaching approach influences the students' way of learning'. Keywords that originated this category: approach, student, subject, content, dynamics, freedom, book, research, practice, class, and videos.
Individual and collective practices	The exchange of information and resources between two or more teachers by various means of communication.	All participants presented reports of experiences for this category.	Teacher, exchange, practice, GRE, sharing, planning, and experience. Additionally, this category is supported by the quality assessment, which is a negative or positive degree of excellence in the practice performed or artifact. Keywords that support this are: Better, perfect, bad, good, adequate, legal, and practical.

[3] GRE - Regional Management of Education (in Portuguese: *Gerência Regional de Educação*) is an organ that integrates the basic structure of the Secretariat of Education, which must exercise the following, at the regional level: actions of technical supervision, normative guidance and articulation and integration, with a view to improving the quality of education, etc.

Well-being (subjective pole)	The processes by which an external or internal stimulus causes a specific reaction, producing a perception, thought, feeling, or emotion	All participants presented reports of experiences for this category, except participant PE6.	Happiness, sadness, frustration, desire, insecurity, ease, attempt, and fear.
Lack of time	Insufficient period for carrying out an activity.	All participants presented reports of experiences for this category.	Time, fast, fast schedule, free, class, and time.
Improvisation	Carrying out an activity without requesting preparation or knowledge.	All participants presented reports of experiences for this category, except participants PE1, PE6, and PE7.	Adapt, try, prepare, write down, check.
Knowledge and Resources	Information, knowledge, and palpable objects or results of software development.	All participants presented reports of experiences for this category, except participant PE6.	Information, knowledge, notebook, computer, projector, Internet, books, flash drive, research, questions, slides, smartphone, sound, tablet, use, and videos.
Information systems	A computer system that organizes, stores, processes, and transmits data.	All participants presented reports of experiences for this category.	Site (Website), SIEPE (Pernambuco's Education Information System), Google, YouTube, Internet, and WhatsApp. Additionally, this category is supported by the Internet, which allows the exchange of data and messages between geographically dispersed users. Keywords that support this are Internet, search, slides, video, YouTube, research, and experience.

Source: The author (2022).

These themes are present and inextricably linked to the narratives discussed below. In the next section, we organized two narrative descriptions. Their temporalities are associated with moments before going to the workplace and after leaving it. The first subsection explores the lesson preparation practices carried out by teachers while they are still at home or in environments organized for teachers' professional

development meetings. In the second subsection, we will present the challenges faced at school and teachers' intentions when carrying out teaching-learning practices with higher quality.

2.3.1 Before Arriving at School

The temporality of collaborative lesson planning is ample. It starts even before teachers go to school. The teacher plans lessons at home for several reasons: lack of time, insufficient infrastructure to access the Internet, and a quieter place to work than at school. From home, they conduct searches and exchange knowledge and resources obtained with other teachers via the Internet. They utilize a wide variety of physical and digital artifacts.

Luana reports: “What class am I going to today? Oh, if I have a class where I have to take a book, or something else, I have to remember that (Luana displays the schedule)”. Another example is given by José. He shows part of his work environment at home, using a laptop to organize digital artifacts, such as slides and text documents (see Figure 3). The use of the laptop enables him to organize and store digital educational resources. Due to the lack of practice and difficulties in accessing the Internet from school, it is necessary to search for materials at home. When producing or downloading material from the Internet, he is used to transferring all digital stuff to a flash memory or sending it to his email box. Both, as mentioned by José: “Yeah! I had a flash drive with that saved, I just don't know where it is. But if anything happens to the computer, I'm lost! You have to redo it. I mean, some are saved in the email. But I think most of them are saved only on the computer.” José reported that “Sometimes the material is already at the school, on the computer… we leave it there and let the other know that it is there. Or, for example, if I have it in my notebook, I go to its flash drive, check it in email, things like that...”. Teachers creatively improvise ways to store materials, and design their instrumentation system (MUNOZ; BOURMAUD, 2012). There is a dependency on digital devices that have memory functions. As they are physical items, they may be lost or may not work. If that occurs, it can cause workload or affect well-being. Eventually, newly designed materials may not have the same quality as the original nor promote features to support the organization and management of resources.

While planning lessons annually, teachers consider the official Curriculum Parameters of Basic Education and the Pernambuco State Curriculum for Basic Education. They do so according to their respective area of teaching, according to the learning expectations, and based on axes/fields, and contents. They are aware that preparation to teach specific axes/fields must be bimonthly. However, due to daily demands and contingencies, improvisations emerge and teachings go on inside the realm of possibility, as is observed in the experience reported by Amanda: “It has to be! Thus, I cannot change it as I would like to because of the State’s provision of a curriculum. So, I got to have this subject in the first unit. We are not free or allowed to change the content. I don't have that freedom. I just have freedom about the approach I take. The way I will address it is my choice. There is no standard. ‘Ah! This school here has a constructivist model, a traditional model’… it doesn't have that. I take whatever approach I want. But I have no freedom at all.” The coordination between the state curriculum and its effective realization in each of the classes is a practice that requires organization and planning. Due to the daily contingencies, the activities are carried out, but differently from what was planned. Fickle performance is one of the factors that promote negative feelings, such as frustration and sadness.

Choosing and organizing media in flash drives is common among teachers, as mentioned by Amanda: “It's my life. Yeah, on the thumb drive! I don't have a printer at home. So, I just organize everything, put it in the flash drive, then get here… I go to the [sic] office, print it out and take it to photocopy.” Even though there is the possibility of using e-mail or any other information system for these purposes, the use of this artifact was presented as usual: "I don't have the habit of sending it by email. Only using the flash drive itself”, Amanda said. The teacher organizes the resources for each class and transfers them onto a flash drive. There is a considerable complexity to manage the correspondence of materials and class. Occurring an eventual problem or unavailability in the use of the flash drive, they improvise this management. Amanda doesn't use cloud storage because she declares she doesn't have the skills for that. She reports that if there was an easy-to-use web system, she would definitely adopt it in her teaching practice. Such a system has to deal with all those overlapping contingencies. We can see that there is an emotional load related to the hardware, which is used as a file organizer, resource exchange facilitator and an extension of working memory.

Teachers register what they have to do in many distinct ways. Those vary from taking notes of what will be taught, what was taught in the classroom, scheduling for the resumption of the subject in the next class, observations of student behaviors, especially for reflecting on successful and unsuccessful practices. These registers are commonly made on paper, or in a notebook or an agenda, as reported by Felipe: "But I have a diary. I don't have it for the whole year, for the whole discipline. I have the whole structure: objectives, resources, evaluations, references. I have done all of those things, some, and it is in the diary at home. It is at home. I must have 4 or 5." The choice for these artifacts is due to the facility of handling and transport. There are subsequent efforts to index, search, and retrieve notes or records.

Notebooks are intensively used in the first months of the school year. Over the months, the number of activities in the teacher's routine progressively increases. Concomitantly, the recording frequency decreases. As this continues, there comes a time when there is no more time to take notes (see Figure 04). Thus, teachers try to memorize the data and information in their working memory. However, there are significant data losses, which could be relevant for action-reflection-action and lesson planning.

The notes are taken to compose a kind of report of the job, insights, and sticky notes, done by the teachers. Those records are stored for months or years until they are definitively discarded, as reported by Francisco: “Tomorrow I do this [class]. So, there are more [notes]. A lot more than [classes] without registration or even, but like that: from the head, on scratch paper. I have to do that tomorrow.” Teachers create their own file systems, with rules and styles. Files are organized so they can be easily found and read or reused. However, part of the work memory executed is lost over the years. Amanda reports: "I try to organize myself so I do not get lost. There are many classes that I do not write down, then when I note down, I do not remember, and I get confused. Sometimes, I write something generic on the computer. It was not what was effectively worked on, for example. What was actually worked on is not reported." Bruna stores parts of the information in her work memory. It is clear that there is a flaw in this "file system". These losses or frustrations can be mitigated by a system that is designed and suited to the complex relationships characteristic of planning activities. However, she considers this a handicap, not having the technological skills to quickly make records in digital format. Bruna has created a mental condition that makes an activity easy for some people, but difficult for her. The imposition of limits or resistance

to the use of digital technologies already available may be due to lack of knowledge of the software or a consequence of the lack of time generated by the many planning and teaching activities. Research reveals that work overload can generate momentary working memory deficiencies and exhaustion among teachers (DIEHL; MARIN, 2016; TREVISAN, 2020; TABARES-DÍAZ; MARTÍNEZ-DAZA; MATABANCHOY-TULCÁN, 2020).

Figure 3 - Draft information sheet and Laptop at home

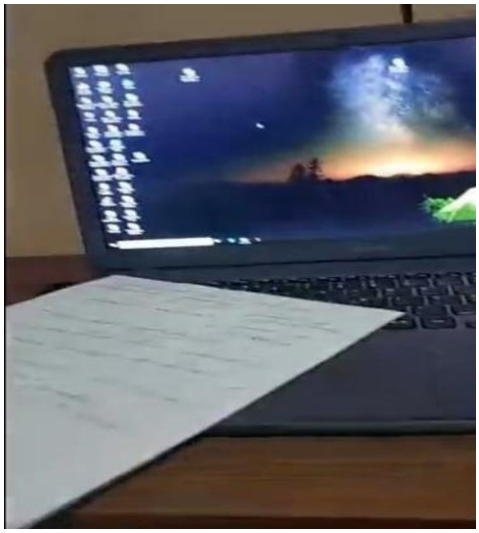
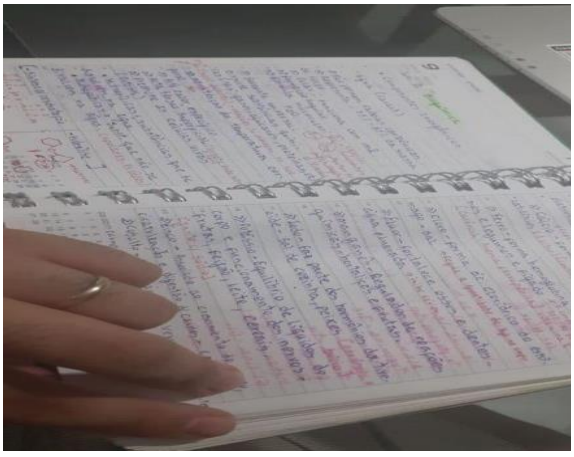


Figure 4 - Notebook for recording teaching-learning information



Source: The author (2022).

When preparing classes at home, teachers search on the web. These searches are performed weekly and, if necessary, daily. The most commonly searched items are exercises, videos, presentations, and content to be inserted into their lesson planning. For teachers, a few educational websites are references and provide those contents. Teachers search Google® for a specific subject. The search is continuous until they find satisfactory content. Therefore, the accumulation of searches allows the teacher to learn and improve a mental and individual system of searches for digital educational resources.

Searches present a degree of complexity. It is often necessary to search through different websites because teachers do not know specialized platforms that can be used as a reference for planning activities. In addition to the content, teachers look for resources that present reliability and quality. Reliability is related to the author of the content. If it is a recognized person, the decision-making for the resource selection is easy and fast. However, if it was created by a person he does not know, an alert is created, making the resource analysis more judicious. Teachers use a

quality filter for the process of searching and selecting educational resources. Furthermore, they customarily access YouTube® to view and learn from other teachers' shared experiences and practices (OLIVEIRA, 2016; NACAK; BAĞLAMA; DEMIR, 2020). From this self-directed learning experience, teachers incorporate and/or adapt to his planning everything that is considered pertinent and appropriate for their classroom context. Therefore, the search for resources could be facilitated through a specific filter system for the educational context. In addition, there could be elements that corroborate the quality of the digital resource and recognition of teachers who have their resources reused by other teachers.

When moments before going to class, teachers manipulate digital resources on their smartphones, they are used to consulting the digital books adopted in the classes. This usage complements the lesson planning activity, in the sense that it is a situational lesson planning practice. Despite not being a comfortable or desirable circumstance, they perform an action-reflection-action. They take a cursory look at the book's subject to recall the point where he or she left off in the last lesson. Sometimes, they take note of this point on paper or rely on working memory. In certain cases, teachers need to ask the students 'People, where did we stop in our last class?'. We can interpret those modes of registering as situated creative improvisations. The absence of even simple notes can be a source of stress and cognitive overload or frustrations. On the other hand, a simple and functional way to register and circumstantially recover this information can overcome or even avoid negative experiences.

The lack of time (SAAD, 2011), an unsuitable place to work and poor quality access to Internet are some reasons why teachers carry out their work activities at home. Amanda reported: "At home, I usually get a little better quality. First, I do it more calmly (at home) because here everything is very busy (at school). Secondly, here, for example, the Internet does not catch on. So, I have to use my Internet to be able to search on the Web. The Internet here sucks. And you can read more calmly with it, right? At home, I do a more elaborate job than here, since here it's very busy." Teachers in general receive low salaries. Thus, they are driven to have more than one job and increase the number of hours worked. They need to teach at more than one school and have other occupations, aiming to supplement their income (SCHMITT; VIEIRA; MARTINS, 2018). The links to various jobs increases administrative chores existing in the schools, among the other activities arising from the profession.

Teachers use WhatsApp as a channel to mediate knowledge and resource exchanges. It connects experienced to novice teachers. People mainly use WhatsApp only for communication. Due to the need and possibility of sharing documents and media, teachers improvise it as a platform for professional exchanges. Exchange of knowledge and resources occurs between teachers from different origins and levels of experience. José reports: “Oh! Yes, there is a way, we are math teachers like I said, we have the training, you know? Then we have a group on WhatsApp. This is the GRE Vale do Capibaribe. There is a WhatsApp group with almost all high school teachers from the GRE. There are frequent exchanges. There is a teacher mentor, right, who manages the group. But like this, there is always a teacher posting 'Look, such and such material', 'This issue here' (educational resource)". The whole group exchanges materials, websites, and 'interesting' works, and teachers continually learn from exchanged knowledge and reuse shared materials. Meanwhile, neither collaborative learning is structured, nor are the materials organized in a structured way.

Teacher Ana complements, “It's personal. Then, when we need to send it to another teacher, we use WhatsApp. Otherwise, I print and give them the content they want"; “It's more through WhatsApp © like... I was working on hormones once, and when I researched using the Internet, I found one [piece of material] that was very exciting, but it was all in English. When I took it, I had the idea to also work an English subject. Then I sent it to the English teacher, and we worked together. We set up a panel on hormones, and then all the information was presented in English (...) then she worked with them in English and I worked the biology subject". Creative use of digital platforms allows coordinating new planning scenarios. After exchanging resources, professionals use resources for different purposes. To complement, Francisco said: “So, then there is also an exchange of files exchange on WhatsApp with a group of teachers” The instant messaging software allows professionals to communicate effectively. WhatsApp fuzzily serves to mediate for personal and professional practices. Its good usability has led teachers to creatively appropriate it professionally. However, it is very complex to handle the complexity of communication channels, deal with urgencies, task prioritization, private communications, and manage materials for reuse using the same platform.

2.3.2 Improving Classes and Overcoming Challenges at School and Afterwards

As we have seen, the teacher's everyday life is filled with a plethora of personal and professional activities. In the middle of all these activities, he or she is faced with unforeseen moments, leading teachers to improvise or not complete the activities. All teachers want to give the best classes to their students. However, negative feelings and emotions (well-being) arise when facing reality, obstacles, and limitations to teaching and learning.

Amanda reports: “Today would be my time for planning. However, I have to teach chemistry, biology, and mathematics. That is, in practice, the time for planning doesn't exist.” These contingencies interfere with individual and/or collaborative practices. For this reason, it is frequently necessary to perform lesson planning at home, using their leisure time. Working at home struggles with time to rest, time to be with their families, or time for other personal duties. Besides, the teacher works overtime, for which he is not paid.

As Francisco reports, lesson planning also occurs at the beginning of the class. He says, "it's less than an hour and I don't have time, so I'm running around, and I don't have time”. In addition, Ana confirms "many things happen all at once." Combined with lack of time, work overload can decrease satisfaction with the balance between time spent at work and time spent on other aspects of life (FAGAN et al., 2012).

The GRE is a sector associated with the Department of Education of the State of Pernambuco, Brazil, that promotes technical supervision, standardizing guidance, articulation, and integration. The performance of this administration sector aims to improve the quality of teaching; promote coordination and implementation of educational policy. Francisco evokes that "once a month, once or twice a month, we have training promoted by the GRE." This institution allows the meeting of groups and collaboration between teachers.

Nevertheless, the Regional Education Management (GRE) demands compete with class preparation and classes themselves. Luana reports: "So as we spend all day at school, we have these moments designated for studies. They are already allocated on the schedule. Ideally, we could plan at school, but we always bring work home, even if there are no conditions to do that. However, unfortunately, at some moments we still have to fill out the online academic system (SIEPE), for example, on

the electronic notebook. And there are deadlines to fulfill. And we sometimes have to plan lessons, right? There are some official demands with deadlines (...) and then we are sometimes obliged, when there are deadlines, to plan at home." Considering the different commitments teachers experience, they must prioritize their schedules to keep tasks under control in their routines. The time to do the planning at school is seemingly almost always sacrificed.

Experience exchange and resource sharing took place during the meetings promoted by the GRE. Ana reports: “They are new models to dynamize or make games (in class), make a podcast, or record videos. In these meetings, we exchange information and ideas with other teachers. In this way, we keep up to date.” When re-enacting the planning practice, Ana mentioned that “these here (games) I received from a colleague during a GRE training. (...) I found it interesting, and she passed it on to me. I talked about my experiences with her, and she reciprocated by sending me this game.” Face-to-face meetings naturally provoke collaboration, exchanges of experiences.

Insufficient physical infrastructure and inadequate equipment, as well as diverse requirements, are factors that limit the performance of teachers' work. Luana reports "If you are going to teach a class, maybe using images, for example, the ideal would be a classroom with a projector, with PowerPoint © and such. But, sometimes it's not possible [sic]. School doesn't have enough equipment, anyway (...) you know. The equipment needs to be reserved in advance (...). So, these kinds of things end up weighing on planning. So, I can't say that I will be using a projector in all my classes. There is no way. So, it weighs heavily on the planning itself and the execution of the planning." And, "It's bad, it's bad! Because, at least for me, silence is important. Here (in the teachers' room) there are always people moving, it is abuzz. People come in, talk to you, then you lose focus. I prefer a quieter place." Based on these circumstances, teachers are usually being creative to deal with contingencies. Creative improvisations involve experiences and knowledge acquired during professional development (HALETA; BALANUTSA, 2021).

For Francisco also, "the school does not offer adequate space for you to be able to do activities. Many other people stay in the teachers' room, even if this room is for teachers. All the time, they (...) disturb our concentration. It also doesn't work well to work in the library. There will be someone studying there. There are places, but there is no access to a computer and the Internet. You must do the planning, conduct a quick

search, and use personal resources at the school on a smartphone or computer." (See Figure 5 & Figure 6). It is not always possible to deal with the previously mentioned limitations. Thus, teachers need to deal with the desire to teach and produce better classes, and the feeling of frustration of not having been able to carry out plans according to the lesson plan (SKINNER; BEERS, 2016).

Besides, the preparation takes place in the classroom, and teachers use smartphones to search contents and lesson samples. There is a trick to using the smartphone in-class preparation. As Felipe states: "Even in the classroom, I frequently pick up my smartphone during class, take a look, choose an exercise and use it. I look at some… some details during the class. No, no embarrassment about using the smartphone, no embarrassment." It was incorporated into teachers' practices, from planning to teaching in the classroom. The teacher researches and finds resources on the Internet through the smartphone.

Urban violence influences smartphones over personal computer usage due to the home-school-home commuting, as reported by Felipe: "Everything is on my smartphone, I do not touch it (the textbook). I'd rather not lecture with a book in my hands. I developed an aversion to paper books. Smartphones and tablets are my things. I do not use a tablet here because I take many buses, and I prefer not to risk being mugged. But I have an iPad Mini at home." Teachers deal with difficulties like these daily.

Figure 5 - Laptop and notebook for recording information at school

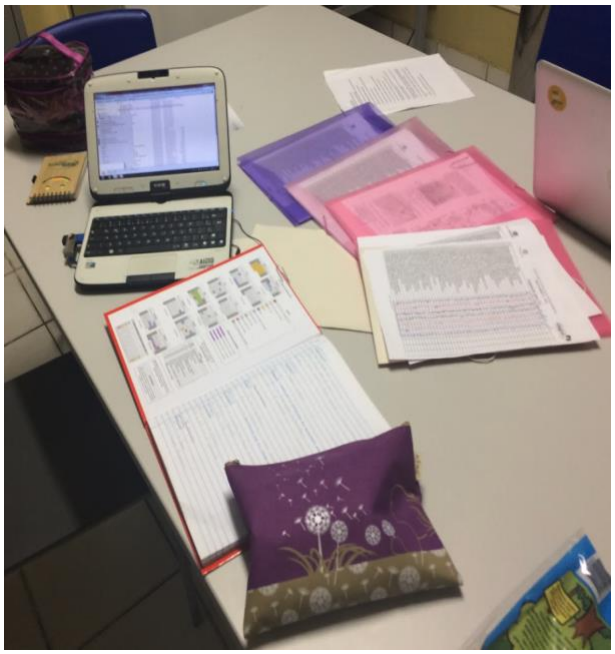


Figure 6 - Cabinet with books, notebooks and stereo, arranged in the room

Source: The author (2022).

In addition to the teaching responsibility, besides the school's physical infrastructure, there are also time limitations, audio and visual equipment unavailability, and the professional detachment of the teacher. PE6 reports that he has to carry out isolated activities in the classroom because there is no other teacher in the area to share practices and resources. He explains that: "we review, and planning is dynamic, right? Because you do the planning for one class. Each class is not similar to another. Moreover, unforeseen events also happen. For example, (...) suppose there is no water at school. That sometimes happens in the neighborhood here. Then we check it out. Then students cannot stay at school, in class. Then, I was supposed to teach [sic]... I did not teach, so I redid all the planning. Usually, planning is dynamic. There is one Physics teacher for the 2nd and 3rd year of the secondary level. So, I had to plan by myself". Such contingencies directly interfere in planning practice and teaching-learning. Unforeseeable frustrations are common in planning and teaching practice.

Collaborative lesson planning occurs when the teacher is not as isolated. Teachers carry out collaborative lesson planning. The purpose is to discuss and share ideas and knowledge (see Figure 7), as reported by Maria: "In this case, we are at the start. We sat down, and generated ideas, right, Luana? However, like this, we sat down to start a planning process. We see what would be necessary concerning the

textbook's content, which we are browsing through now. We see, thus, what would be necessary. So, the textbook is a kind of guide. As this elective is a new thing, we are trying to put down something like this, still simple, which is the beginning. First, for us to see the meaning of what we want to do in this practice of Physical Education." When there are available times, resources, and interests, planning also occurs during the teachers' vacant hours or at a fixed time in their class schedule. They are not just writing down traditional lesson plans, but they are planning. Collaborative lesson planning is seen as desirable and dynamically performed, despite all constraints.

Students are active agents, and they can influence lesson planning. José reports: "Many times, there was even a student saying: 'teacher, look, see what I found; See what I learned there. It is really cool.' So, I say 'Okay! Let's show the other students how you do it and how you work it'. (...) It is notorious that some learn one way, the others learn differently, so I think it is very positive to make for a new way." From interactions with students and diagnoses made by teachers, it may be possible to plan classes for specific contexts and people.

Figure 7 - Teachers in Interdisciplinary collaborative lesson planning

Source: The author (2022).

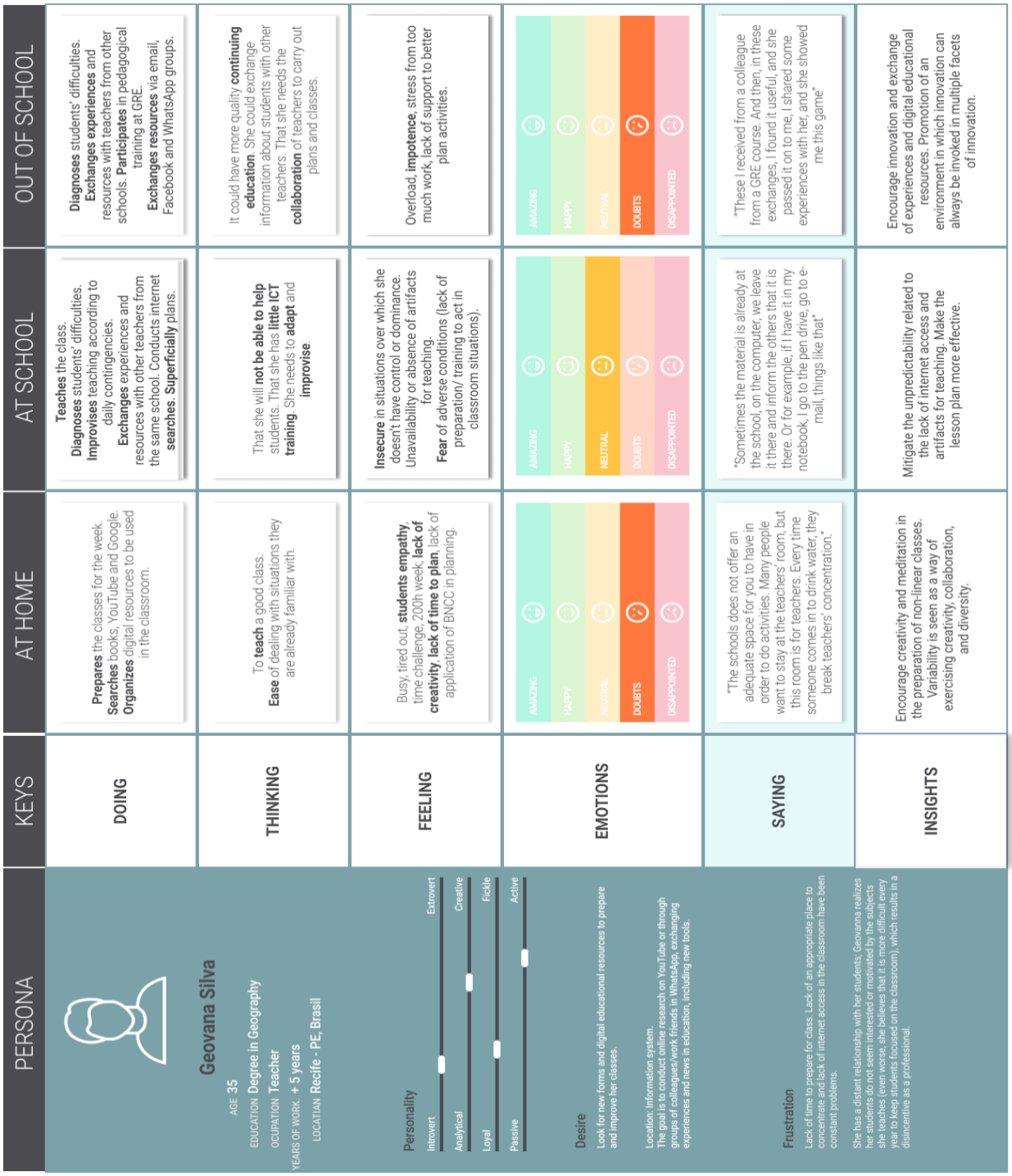
Teachers strive to offer the best teaching and learning possible. José had to teach a subject that he was not proficient with. Without the proper training, it happens that teachers accept such a challenge to teach the entire school year. He reported: “I'm not good with Physics. Last year I taught Physics the first year. It was “Oh”. This

year I teach the same group of students only Mathematics. I received some positive comments from them along the way. I was insecure. I even said to them, ‘Guys, I have difficulties in Physics. I'll be very honest with you, but I will do my best.’ So, they even recognized me, saying 'You are the teacher!'. This year I teach Math classes. Then they sent me very positive comments again: ‘Teacher, you are good at Math’. Sometimes, teachers need a ready-made plan to serve as a starting point for a challenging situation like this. The good teacher-student relationship can positively influence teacher motivation. In this case, good feedback can stimulate teachers to improve planning.

Teachers wish to exchange experiences and educational resources with peers. Amanda stated that planning together with colleagues would be ideal. Ana reported that she would be motivated to carry out CLP because it helps her to enrichen classes: "The experience was good, right? Because there was a lot of material available, right? I got examples of exercises, tests, and simulations from there, right? Moreover, they had updated video lessons, which we would then watch and add some information to my classes there, so it was very significant." The role of peers in a planning activity has specific mutual values. Collaborative lesson planning allows teachers to help and support each other in daily activities. Ones' teaching experience can be shared with colleagues, promoting community exchanges and knowledge construction (SCARDAMALIA; BEREITER, 1994).

In Figure 8, we synthesize the main findings on CLP activities described above. We could create a persona to represent typical participants (FERREIRA et al., 2015). The PERSONA is named Geovana Silva, 35, who graduated in Geography with over five years of experience. A client journey structure describes how teachers spread work between home, in school, and outside. It was also deployed using empathy chart dimensions (BLAND, 2012; FERREIRA; CONTE; BARBOSA, 2015) to illustrate what teachers do (DOING), think (THINKING), feel (FEELINGS), experience (EMOTIONS), say (SAYING) and perceive (INSIGHTS).

Figure 8 - User journey: Geovana Silva's situated CLP



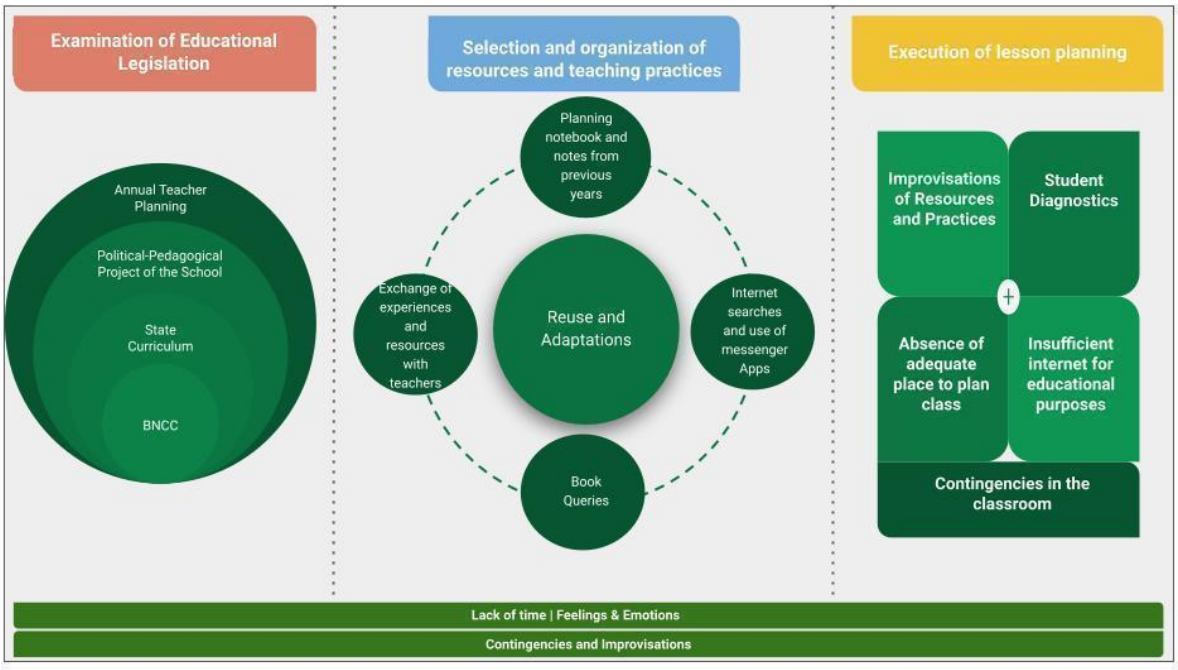
Source: The author (2022).

In a second effort to synthesize, in Figure 9, we present an illustration of CLP activities distributed over time: the Common National Curriculum Base (BNCC), educational legislations, documents, physical space, people, organizations, contingencies, improvisations, and well-being. Formally, planning practice is regulated and supervised and teachers are aware of that. In the column 'Examining Educational Legislation' of this figure, we schematize the intrinsic logic that teachers must follow to develop their planning in accordance with national (BNCC) and State official documents. The BNCC is a normative document for the school system. It is a mandatory reference for school curricula elaboration. One finds the objects of knowledge (content) and the skills students are supposed to develop. Teachers find pedagogical proposals for their teaching according to the level of education in which they work. The state Curriculum extends the national one, integrating the State Educational Systems' particularities. In the same logic, every local school must produce its own Political-Pedagogical Project (PPP) document, contemplating both national and state guidelines and incorporating regional and local cultural practices and nuances. Teachers should develop their annual teaching plan based on PPP at the beginning of the school year. The teacher seeks to externalize learning expectations consecutive to the annual teaching cycle. He or she prescribes which methods can be used to obtain the expected results. Personal planning must consider the goals and objectives of the school in order to guide the achievement of the expected results. Teachers continually realize short-term lesson planning throughout the year according to the circumstances (SILVA, 2020).

The teachers' practices of 'selection and organization of resources and teaching' encompasses orchestrating the availability of artifacts and situational conditions. The reuse and adaptation of teaching materials are standard practices among teachers. The reuse of a resource is guided by the teacher's need. According to the planned circumstance, the teachers adapt resources and present them coherently to the immediate reality. Practices are carried out. Teachers use applications connected to the Internet, search and exchange resources, share knowledge and guidance on teaching. Practices are adapted to the class in which they will be performed. The teacher uses the textbook as a guide resource (GAK, 2011; KNIGHT, 2015), an artifact considered reliable. Teachers trust textbooks as a reference to plan with. They consult specific subjects to be addressed.

Following the initial planning, teaching takes place in the chaotic environment of the school. Multiple activities intertwine. Many contingencies arise from the inadequate physical structure, individual students' needs and lack of availability of educational artifacts. Those events alter teachers' planning. Teachers experience isolation because of these circumstances.

Figure 9 - Improvisation of collaborative lesson planning activities



Source: The author (2022).

In the next section, we discuss how collaborative practices are limited due to those contingencies. We advocate how those digital technologies can be rethought to promote better possible digital futures for CLP.

2.4 DISCUSSION

In the last section, we tried to depict CLP as a collective and distributed activity, a situated action-reflection-action collaborative practice. Collaborative lesson planning is distributed among environments and shared artifacts. It contributes to the professional development of educators and students and improves interpersonal relationships between them. Collaborative lesson planning is paramount for effective and quality teaching-learning. Teachers do not have enough time, support, or adequate guidance for class building. The time and space boundaries of these

practices are fuzzy. The teacher's experience includes undesirable contingencies, frustrations, and creative improvisations when carrying out the CLP.

Due to constant unpredictability, they frequently fail to attain the planned learning experience. Effective collaboration is unstructured and non-sequential. They seem to continually need inspiration for creativity and innovation.

After discussing the themes that synthesize collaborative lesson planning, we reflect upon the implications of the results for the recommendations design of collaborative lesson planning systems.

2.4.1 Action-reflection-action Practices

According to Konno, Higuchi & Mitsuishi (2009), action-reflection is a practical approach to improving teaching skills and lesson plans. Teachers' reflection allows tacit, professional, and collective knowledge building. It directly impacts current teaching-learning practice and guides future lesson planning. Action-reflection allows teachers to appropriate pragmatic and scientific knowledge.

As described in the literature review and corroborated in our results, teachers deal with constant contingencies and improvisations. Therefore, the scenarios at school influence how teachers dedicate themselves to reflecting on some subject. Students' develop as a consequence of the interaction between them and the teacher; and more broadly, between the school institution and society (ALARCÃO, 2005). With lack of time and workload, teachers prioritize activities that impact actions in the present. When reflection-action is carried out at home and in reasonable time, teachers plan and collaborate closer to their desired goals.

Action-reflection-action practices lead to the need for recording or taking notes so that there is articulation between experiences and available time, to plan in the present or anticipate future experiences (PETKO et al., 2019). This practice is not limited to reflecting on present class performance, but allows for reflection on action and reflection in action to fuse the temporality of the planning-acting activities. Taking notes seems to support and contribute seamlessly to the teachers' professional development. They contribute with the designs of possible new learning experiences.

Matured professionals take notes to register and support reflections on planning. Practices' completeness and quality are progressively less considered. Records are more and more 'registered' in their own memories. Carmo (2015) identifies

that memory can act as revisiting voluntarily and involuntarily. This process requires the direct involvement of teachers. The remembrance process proves to be important for the present and future performance. Planning occurs correctly when thoroughly and explicitly detailed. The teacher feels better and the teaching corresponds to what was planned.

Be they aware of it or not, teachers mobilize a design mindset. Over time, several experiences impulse learning and reflection on action. Based on his or her own experiences, the teacher designs lesson plans (LEVIN; ROCK, 2003; BAHNG; LEE, 2017). Previous experience is recalled in the present when preparing lessons.

2.4.2 Constant Unpredictability, Contingencies, and Creative Improvisations

Teachers aspire to and know that CLP practices can contribute to their teaching development (XIAOFENG; QI; LING, 2015). Meanwhile, the evidence reveals that making in-school CLP is challenging, complex, and makes serious collaboration with other teachers outside the school difficult. Teachers are used to handling constraints and frustrations, creating situated improvisation strategies in the ongoing activities. In this section, we tried to bring together some examples of how they overcame adverse situations and inadequate conditions.

Notably, frustration is constant among the interviewed teachers (DIEHL; MARIN, 2016). The lack of time to carry out their activities provokes frustration because they cannot perform the planned classes and guarantee the desired quality. They wish to perform high-quality teaching-learning experiences. Meanwhile, they face numerous barriers to their professional practices. How can teachers overcome all constraints and perform a quality learning experience? Teachers usually try, but they constantly become frustrated. Overall, students' educational performance is objective evidence that achieving the expected educational impact is difficult. The dynamics between well-intended attempts and becoming frustrated can enter an iterative cycle. Teachers continue trying to perform acceptable practices, creatively balancing their frustration with experience generated in previous years. This evidence is a relevant aspect to be considered when designing individual or collective digital support, as we will consider in a later section.

Participating teachers have declared that CLP makes their teaching-learning preparation more prosperous and efficient. This corroborates with what we have stated

above: that collaborative class preparation is a collective action-reflection-action feat distributed among people and environments (VANGRIEKEN et al., 2015). The connections are initiated during the regional administrative office (GRE) institutional and educational meetings. Those events boost collaboration, since teachers use the occasion to exchange experiences and tools with peers. After each meeting, those exchanges of experience continue through information systems, such as Facebook ® and WhatsApp ®. In addition, digital platforms mediate communication and digital media sharing. Collaboration is essential for professionals. It allows for expertise and successful practices in exchanging and learning. It can trigger the development of new teaching-learning approaches. Continuous participation in teaching practice communities raises teachers' well-being, security among peers, work satisfaction, and feelings of accomplishment concerning the preparation of classes and before carrying out teaching (HAKAMI; HERNANDEZ-LEO, 2021).

Lack of time causes teacher isolation. Teachers do not have enough time to communicate and exchange experiences with colleagues. Teachers' time is dedicated to teaching classes, creating activities, or reusing other teachers' educational resources. The activities are frequently performed in a limited time slot. Quite often, there are no free or flexible moments for carrying out an innovative activity, perhaps in the form of a fun exercise, requiring time and creativity to plan. So, lack of time is a significant cause of dissatisfaction and frustration for the teacher.

Teachers' collaborative practice follows a particular routine. It is used to being supported by digital platforms to exchange resources and build knowledge. This type of practice does not follow any fixed process. All teachers are used to experiencing moments of creativity when preparing their classes, but mainly while teaching classes. We observed the significant impact of constant lack of time related to lesson preparation. This factor leads teachers to improvised actions, such as adaptive reuse and the use of digital media. Teachers improvise when no devices connected to the Internet are available at school.

In spite of institutions' having a role in maintaining educational systems, teachers do not fill in forms based upon formal lesson plans in those systems (at least not hastily) because they do not have enough time. They use the official electronic system as much as possible. They fill out the forms, but there is no reflection on the activity performed, carried out instinctively.

Teachers use many devices and design others. The computer is a fundamental instrument in the lesson planning activity and is used for the school's collective use. At the same time, digital educational resources are stored on the computer or flash drive. These resources are organized into folders divided into subfolders and school years, and the teacher's classes. In each class, the teacher accesses the files. Sometimes, it is necessary to plan the lesson on the personal computer at their home. Even though there are technological resources on the computer, the teacher does not give up on their physical notebook, handouts, printed-out attendance role, and even the year calendar, printed out and pasted on the cover of the notebook with important dates. The usage of a physical organizer is crucial in lesson planning activities. The cabinet in the teachers' room is a unique place where books, notebooks, paper drafts, audio equipment, and a projector are kept. In addition, the physical space is shared with other educators at the school.

The teacher enters lesson planning in the Education Department of the State of Pernambuco's Information System (SIEPE) (https://www.siepe.educacao.pe.gov.br/). On the web-based platform, information about the classes carried out is inserted. The teacher also uses the smartphone as an instrument for teaching practice.

Teachers use the textbook as a guide for their lesson planning activities. Additionally, the teacher seeks to carry out collaborative planning, but it is necessary to improvise on interactions with other teachers due to the lack of time. Teachers store information in their memory, even though they consider it non-reliable. In general, teachers do not have the technological skills to create more complex registrations in digital format.

Additionally, relationships with other people influence their activities (CHARTERIS et al., 2021). Manifestations by other teachers, principals, school staff, mothers, fathers, or guardians of students, and other factors in the school's social context, further increase the teachers' responsibility to carry out the preparation of efficient classes.

Teachers deal with unpredictability in their daily routine. How can they transcend *in situ*, dynamic, and unpredictable contingencies in professional situations? To deal with unpredictability, they must have the ability to confront complex events. Therefore, the complexity involved in the socially and historically established circumstances, including subjective and sensorial aspects, must be considered in the design process (PINK, 2015).

Unpredictability is an essential condition of the complexity of collective lesson planning practices. It is distributed among people, spread over time, and arbitrated by multiple artifacts. In this sense, it should be understood as a sequence of non-linear sequences of hybrid events that require action-reflection-action.

Temporality: past forwards the future. How does one anticipate the way students receive further teaching? The teachers challenge themselves to predict the near future in order to anticipate teaching-learning, including possible contingencies (PINK et al., 2017). The prediction may or may not be confirmed, requiring adaptation, improvisation, and emotional control (EVEN, 2020; WIERCINSKI, 2020). It is not possible to foretell how the student and the teacher arrive at school. All are constantly changing, immersed, and subjected to random and non-linear events (FAUCON et al.,2020). They strive to deal with feelings and emotions. Teachers need to manage alternative strategies, curated materials, digital educational resources, and teaching instruments based on these.

In consideration of design recommendations, we can imagine requirements to (i) deal with unknown events, (ii) relate to feelings and emotions, (iii) relate to digital technologies, and (iv) the school environment.

Temporality: the contingencies that present themselves and the improvisations. The unpredictability of the unknown leads to numerous contingencies during the execution of teaching activities. However, predicting or trying to anticipate an action is a challenge, which can be simple but is often complex at school. The multiple nuances and pace of events generate the unknown, in which the teacher tries to understand and act while there is time. When he arrives in the classroom, his beliefs and plans are tested. Currently, teachers improvise while teaching in the classroom.

According to the conditions of activities, postural reactions, and reasoning, the unpredictability of feelings and emotions eventually arises. "More thoughtful reactions characterize feelings; therefore less instinctive, emotional reactions are of the occasional, instantaneous and direct type" (ALMEIDA, 2001, p. 52). How can a teacher diagnose a student, when the interpretation occurs alongside almost four hundred other students? The teacher faces waves of students' feelings and emotions. Therefore, the teachers need to register, organize, and visualize the student data.

The school is in an environment full of unforeseen events, such as unavailability of the Internet, sudden preparation to replace an absent teacher, or even the

unavailability of digital educational resources, generating unpredictability in digital technology.

2.4.3 Unstructured and Non-sequential Collaboration

When there is an opportunity for collaboration, staff interact with other teachers and recognize the practical value of professional development. Even though experiences are circumstantial and individualized for teachers, digital platforms allow mediation in synchronous and asynchronous communication, organization, and the reuse of media used in sharing.

Teachers have the professional capacity to deal with unstructured and non-sequential collaborations. Collaboration occurs when two or more teachers work independently or together to share information and knowledge, plan and solve problems, and improve the educational process and results (OECD, 2009). Teachers cooperate in formal and informal ways, including team teaching, peer observation, coaching, general collaborative research, team planning, and joint activities between classes (TICHENOR; TICHENOR, 2019). We noted that participation in unstructured and non-hierarchical collaboration during work situations could be fundamental. Collaborations promote exchanges and learning. When collaboration is direct, straightforward, and non-sequential, interaction is possible. In those situations, engagement is more productive, and there is tolerance for unexpected events.

In addition, the collaboration between teachers should enable young and experienced professionals to learn from each other. There is latent intergenerational knowledge among teachers. Moreover, respectable exchanges can take place between veterans and beginners. It can be highlighted that professional development is based on trustworthy relationships among peers. However, the time spent at school is insufficient to carry out teaching work. It is common to cooperate during class breaks.

The state-of-the-art literature on CLP activity is valid, though some gaps exist to guide the process of the collaborative platforms' project. (VANGRIEKEN et al., 2015; DUFFY; GALLAGHER, 2017; CHARALAMBOUS et al., 2021; GARCÍA-MARTÍNEZ et al., 2021). Cooperation can promote collaborative creativity with other teachers; and multiple experiences and inclinations for different themes. Groupware platforms are alternatives to support group collaborations. They promote peer co-creativity, exchange, and digital educational resources (PIMENTEL; FUKS, 2011). We do not find

satisfactory evidence to conclude that groupware supports unpredictability. Experience, with the time available, encourages creativity, innovation, and non-sequential collaborations. Furthermore, students participate in the preparation process. Therefore, it is an opportunity associated with unstructured and non-hierarchical collaboration.

2.4.4 Seeking Inspiration for Creativity and Innovation

Teachers search for inspiration to promote creativity and innovation (LIU; LU; YIN, 2022). Contemporary professional demands require teachers to improve traditional teaching methods and employ innovative teaching practices (SONIA et al., 2017). Teachers can design creative and innovative solutions. Those are essential skills in complex environments and with scarce resources.

Therefore, how do we innovate in the process of lesson planning? The most common lesson plan model adopted by teachers and curriculum consultants was proposed in the middle of the last century by Ralph Tyler (1949); the model is still used today, with minor changes. It is noteworthy that the static model has become more of a bureaucratic element than an effective educational tool in lesson planning. Furthermore, this same model disregards reality and context, based on formalist and technocratic planning in the educational field (NUNES, 2015).

Variability is seen to exercise creativity, collaboration, and diversity (CRAFT, 2003). Individual creativity can be stimulated by an external agent, a human, or a system. Artificial systems can display content and data to inspire teachers, generate positive results, and allow their professional and, consequently, their students' growth.

Teachers are creative and improvise. Innovation can be generated by incentives. Recently, DICTs have been adopted at the global level in the most diverse areas of education. As a result, educational materials are transformed in the same way that didactic adoption can be planned, developed, distributed, and evaluated (BLASCHKE; HASE, 2016; BALAKRISHNAN et al., 2016).

Educators require further resources and information to expand and develop their knowledge (CALDWELL, 2018; ELLIS et al., 2019). Encouraging innovation can occur by triggering or awakening innovation triggers and insights. Providing suggestions and recommendations based on teachers' experiences can be helpful to make desirable, though unexpected, planning decisions. In this sense, innovation and

creativity can be promoted to deal with the complexity of teachers' hurdles by advocating formats that supplant traditional teaching practices, involving students and teachers within the same classroom and with the classic teaching materials (BALAKRISHNAN et al., 2016).

2.4.5 Reflections for Further Design of Collaborative Lesson Planning Systems

Based on the evidence discussed above, we can reflect on how to design systems to support CLP. Furthermore, we can reflect on the design process itself in a way that can lead to meaningful systems for the participants in their respective contexts.

During the design process, designers must consider how activities occur and how a possible new digital system might make sense for teachers, given the complex circumstances in which individual and collaborative planning occur. As an example, based on the themes discussed in the preceding sections, we could say that a future artifact must meet the challenges of dealing with constant unpredictability, helping teachers manage experiences and entrepreneurial time, supporting unstructured and non-sequential collaborations and inspiring teachers' creativity and innovation capabilities.

Recommendations for Constant Unpredictability indicate that an information system should support teachers in anticipating teaching situations. This functionality of a system can be materialized through questions that provoke reflection or action to anticipate possible unforeseen situations. Interaction styles are needed that support lesson planning in the midst of contingencies that the teacher did not anticipate. From this recommendation, we can imagine requirements to deal with unknown events to be welcomed in situations involving isolation, depending on receptivity among teachers. Such issues could be mitigated by designing unexpected solutions based on making sense of improvisations. It is necessary to design based on the creative solutions of the teachers.

When we anticipate that 'Action-reflection-action practices' is a design recommendation, we anticipate that a collaborative planning support system should allow the capture of experiences lived over the teaching period. This capture can allow and support teachers in activities that involve action-reflection, information recording,

and organization of digital educational resources, working memories, support in generating ideas and transforming them into actions. In addition, it must allow the insertion of what can be done in the future.

Possible collaborative systems to support these activities must present, provide or suggest content and data that inspire teachers in activities for teaching. These recommendations are related to 'Seeking inspiration for creativity and innovation.' As a result of this functionality, one could allow teachers to generate positive results, allow for their professional growth, and consequently, the growth of their students. Personalization can be allowed, as it is a motivating element of pedagogical practice. Innovation can be promoted to enable teaching-learning relationships and interpersonal communication.

We envision that a collaborative system can allow for unstructured, non-hierarchical collaboration. We call this recommendation 'unstructured and non-sequential collaboration'. This recommendation can support the dynamism of collaboration between teachers, including unpredictability, experiences, and time management, encouraging creativity and innovation. The hypothesis is that cooperation can promote collaborative creativity, promoted by multiple experiences and inclinations towards different themes. It is unstructured because the traditional plan does not meet the needs of the school context that teachers face. Non-sequential collaboration exists so that planning can be carried out according to the needs presented, synchronously and asynchronously, between teachers from different contexts, in teaching time, and in different formats of educational resources.

Thus, reviewing, reflecting, and learning from experiences can be challenging when professionals are faced with a lack of time, a consequence of the workload and concomitant professional activities. Thus, collaborative lesson planning systems can support them, capturing grades and elements of teachers' experience over time. In doing so, digital systems can support the collection of notes, records, and resources such as memories, ideas, photos, sound recordings, and summaries of practices for further reflection and learning.

Digital systems can support teachers in time management, promoting collaborative work, co-creation, and mutual support. Ultimately, planning takes place in teachers' spare moments during the day. However, as already mentioned, unforeseen events are frequent. Thus, contingencies are designed to overcome all these unstructured and non-sequential events.

Thus, digital systems can support innovation and inspire teachers' creativity. To act beyond the traditional lesson planning model, they can complement local models with variability and adaptation. Personalization can be allowed because it is a motivating element of pedagogical practice. However, innovation must be promoted to impact the physical and digital structure, teaching-learning relationships, and interpersonal communication.

As the study contributes to the CLP literature, we need to consider the constant changes in the world (PINK, AKAMA, & SUMARTOJO, 2018), which impact teaching-learning, people's relationships, and the use of technologies. Therefore, collaborative systems design recommendations can play a role as possibilities for designing solutions for uncertain and situated contexts.

2.5 CONCLUSIONS

In this study, we seek to build knowledge about the phenomenon of collaborative lesson planning carried out by basic education teachers. We take a situated design approach to understand and describe the meanings of practices and technologies adopted in collaborative lesson planning practices.

The study contributes to the literature with the description and definition of collaborative lesson planning. Our interpretations allowed us to identify contingencies and consecutive creative improvisations in essential activities.

The evidence concludes that collaborative lesson planning occurs in three physical locations: at each teacher's home, school, and out of school. Teachers choose to plan at home. After all, they perceive they are more efficient when the preparation takes place in the home environment because they consider that they can remain more concentrated at home, as the environment is quiet. It has access to the Internet, making it possible to carry out content and media research, exchange experiences, and organize educational materials.

At school, teachers carry out collaborative planning activities. However, the planning is carried out quickly and superficially in this place. The reasons are related to lack of time for planning. This lack of time to collaborate in the workplace creates a feeling of isolation even when surrounded by colleagues.

Teachers creatively overcome the contingencies of lack of time and inadequate infrastructure and create improvisations. The interpretations of these improvisations

allow us to speculate on design recommendations from eventual collaboration platforms. Hence, as one of the results, we defined groupware design recommendations according to the four themes applicable in collaborative systems or possible arrangements of mediators for lesson planning. They are Action-reflection-action practices; Constant unpredictability, contingencies and creative improvisations; Unstructured and non-sequential collaboration; and Seeking inspiration for creativity and innovation.

Design recommendations are advanced in understanding essential aspects of how Basic Education teachers carry out collaborative lesson planning. We highlight some limitations in this study. First, the limits are placed on the sample composed of teachers from a single state of the Brazilian federation. It will be valuable in future studies to consider teachers who teach classes at other educational levels and work in other regions of the country.

3 LESSON-PLANNING GROUPWARE FOR TEACHERS: SITUATED PARTICIPATORY DESIGN

3.1 INTRODUCTION

Groupware tools are recommended to support group work, such as learning design tools (KOPER; TATTERSALL, 2005) and online collaborative lesson planning (CLP) (SILVA; BILESSIMO; SILVA, 2020). Collaborative software enables team members to perform a common task through computer networks, even if they are in geographically distinct locations (CANDOTTI; HOPPEN, 1999). Thus, CLP has become a relevant inquiry topic in Technology Enhanced Learning (NGUYEN; BOWER, 2018). Teachers prefer to work collectively with other educators rather than performing individual activities (PATTON; PARKER, 2017). However, teachers face several barriers in adopting these tools in lesson planning practices, including the usability of the tools and the inadequate space for sharing ideas, needs, or solutions to problems (BODY; MUNOZ; BOURMAUD, 2014; SANTOS; BASSANI; 2020). Situated approaches may explore some of these needs in the early stages of the groupware tool development process (SILVA et al., 2020).

Thus, the present study has used design prototyping procedures and techniques to amplify our knowledge on how these professionals approach lesson planning (DE OLIVEIRA et al., 2014). Dialectically, this in-depth understanding, using multiple methods of participatory design, has guided us to evolve the design of a computational device to support professional lesson planning and to speculate on future digital possibilities for this practice (PINK et al., 2015). The participatory design approach uses prototyping to construct knowledge and to make sense of practices for users through participatory design practices. Thus, this article presents the creation of a participatory design for groupware that mediates the practice of collaborative lesson planning, guided by the following research questions: 1) “What are the expressed needs of teachers when they co-create groupware sketches for lesson planning?”; 2) “Do the teachers perceive that their needs have been met by the co-created groupware prototypes?”.

The article consists of three other sections. Section 3.2 presents work related to Learning Design practices and tools. Section 3.3 describes the method, with the approach, collection, and data analysis procedures. Section 3.4 presents the results

and discussions. Lastly, Section 3.5 includes the final considerations, limitations, and implications for groupware design.

3.2 COLLABORATIVE LESSON PLANNING GROUPWARE DESIGN

This section presents a literature review on collaborative teaching practices, participatory design of groupware, and related work on groupware as a mediator of collaborative lesson planning.

3.2.1 Lesson Planning Practices

Lesson planning is probably the most important activity undertaken by teachers in the proactive teaching phase (CLARK; YINGER, 1977). Thus, the collaboration of an educator is essential for teaching, since it provides teachers with mutual dependence, collective responsibilities, reciprocal openness, and emotional security (NIAS, 1998; LAU; STILLE, 2014).

Teachers must plan, create or reuse various educational resources, which have different levels and complexities regarding their manipulation. Mastering these resources is of paramount importance in order to orchestrate them when executing the pedagogical activity. Depending on the granularity of the learning object, the teacher must arrange quite a number of artifacts. The outline of a lesson does not need to be an exhaustive, complex document. Milkova (2012) reports that an effective lesson plan should provide “a general outline of your teaching objectives, learning objectives and the means to achieve them.” The main objective is for students and teachers to learn from each other (Ibid.).

Teachers orchestrate the central elements surrounding the goals that need to be achieved by the classroom performance, the objectives, and the purpose of the lesson plan. With each choice made, fundamental aspects of planning emerge, and attached to each is a series of nodes that subdivide the key aspects (JOHN, 2006; VU; TCHOUNIKINE, 2021).

The core elements and “nodes” of lesson planning may be adapted or developed according to the context in which it will be applied. Not all naturalistic decision-making is the same, and no unitary process can fit into all situations. The granularity of devising the plan may vary according to the theoretical/practical choices

and learning scenarios applied by each teacher. Thus, this article adopts the concept of the learning experience as an umbrella term for a lesson plan and the curation of organizing resources for a lesson.

Although the origin of the primary model adopted for lesson plans is from the last century, it is still currently adopted by teachers of basic education. However, “it is still not clear whether and how knowledge co-construction projects are related to the use of a lesson plan and the main learning regulation activities” (VUOPALA et al., 2019). The most common lesson plan model adopted by teachers and curriculum consultants was proposed by Tyler (1949) and has maintained the same structure until the present moment.

Despite the formalization of the lesson plan as being a form to be filled out, teachers have adopted it over the years in their school routines, either due to school demands or a lack of knowledge of other practices. Experts have questioned this planning practice: "How can we outline, plan or implement anything if we do not go through the rational cycle of formulating objectives, deciding on strategies, selecting resources, organizing activities, implementing delivery, and evaluating results?" (JOHN, 2006). In other words, the use of knowledge transpires without adequately developing the planning activity.

3.2.2 Collaborative Lesson Planning Groupware

The main features of the tools to support lesson planning activities include guidance, representation, and sharing. Guidance features are functionalities that enable teachers to understand, adjust, reuse, and adopt new effective teaching methods (VU; TCHOUNIKINE, 2021). These are designed to help teachers reflect on their teaching and learning decisions (ZALAVRA et al., 2021). Representational aspects are how teachers may represent teaching and learning activities a priori. Learning design (LD) develops a widely accepted framework for designing teaching and learning activities. Some functions cover the sharing functionalities, thereby enabling the propagation of pedagogical plans among peers (DALZIEL et al., 2015).

Implementation corresponds to tools and resources needed during the act of teaching. Tools are software (discussion forums, wikis, quiz systems) and physical tools (whiteboard, flip chart, pens, articles). It should be noted that LD software needs

to be configured by a teacher, learning designer, or others who are accountable for managing, configuring, and applying it (DALZIEL et al., 2015).

Lastly, student responses are able to capture various types of information regarding student learning, such as outcomes, competencies, skills, and understanding. Feedback corresponds to student reactions, in real-time, to teaching, which may be identified by the teacher and used as information to improve teaching (DALZIEL et al., 2015).

The appraisal of teaching, such as course surveys, can also play a vital role in future improvements in the teaching practice. In assessment, the literature on formative and summative assessment relates to the textbook, since it presents several ways to assess learning. Learning analytics enables a more profitable use of data for educational research, in which LD software systems provide an opportunity for tracking student activity more deeply, since the progress of each student is recorded as a by-product of using technology to manage the sequence of such activities (DALZIEL et al., 2015).

3.2.3 Related work: collaborative lesson planning groupware design

Several studies have contributed to the development of this research. The article “ILDE: community environment for conceptualizing, authoring and deploying learning activities” (HERNÁNDEZ-LEO, 2014) aimed to develop and integrate several collaborative systems to promote the adoption of LD, providing support to mentors throughout the design and implementation processes. The work asserted that teachers cooperate in the co-creation and sharing of digital educational resources. The article does not use data related to understanding the context nor related to lesson planning activities. The work proposes the use of at least five tools to mediate lesson planning. Furthermore, the article does not explore how the transfer of resources and knowledge among teachers will take place.

The work by Batista (2017), “Reconstrução de um Repositório de Objetos de Aprendizagem para Matemática,” [The Reconstruction of a Repository of Learning Objects for Mathematics] redesigns the web repository of Learning Objects for Mathematics (OBAMA), developed as a platform that offers access to basic education teachers. The system has space for the production, assessment, and sharing of lesson plans, which use learning objects found in the repository itself. In other words, teachers

cannot create their own learning objects and use them in their lesson plans. The method is an evolution of a repository of learning purposes. Obama evolved into a mediating tool for activities and class planning. However, the work presents no evidence on how developing a new visual identity and improving aspects are related to its usability, nor how the design and reprogramming of the interface were conceived.

Article "Une analyse de l'activité de planification des enseignants: vers la conception d'instruments," [An analysis of the teacher's planning activity: towards the design of instruments] (BODY; MUNOZ; BOURMAUD, 2014) presents, as a result of analyzing the instrumental system of the planning activity, the real need to support teachers in the creation of educational resources, given that there is a gap in the teacher training process. The study reports that the planning tools do not meet the real needs of teachers and that they are difficult to use. Ten years after using them, teachers still require assistance with the proper use of the tools that help with lesson planning. The study itself ultimately asked why no system meets the needs of teachers in short-, medium- and long-term planning.

Some studies have been developed that center on the design of information systems aimed at planning educational learning units. There is a lack of studies that investigate the conception, development, testing, and assessment of this type of system. This context creates challenges for the development of this work. At the same time, this also raises the opportunity and justification for the development of this research.

In this regard, we have adopted a situated approach (LAVE, 1988) to prototyping in order to broaden our understanding of what is vital in the practice of collaborative lesson planning. This will guide the development of a future system, especially considering that knowledge in the literature is limited.

3.3 METHOD

This article assumes a projective, situated research paradigm while co-conceiving collaborative lesson-planning solutions with teachers. We adopted a situated prototyping practice for the present, which helps to build knowledge and to guide the continuous design of future versions. It inspires reflections and knowledge building with regard to the meaning and usage of the current version and speculations for the various future transformations of incremental prototypes (HEVNER;

CHATTERJEE, 2010). The continually evolving material hypothesis regards the emerging version of the prototype for a collaborative system created to support lesson planning for basic education teachers. The material hypothesis manipulation in participatory design practices continually constructs new knowledge and a new version, converging into a meaningful design solution proposal (KOSKINEN, 2011).

3.3.1 Participants

For the study, the following inclusion criteria were: (a) teachers with three or more years of teaching experience in a high school; (b) in-service teachers in public high schools; and (c) teachers who were voluntarily willing to participate in the research. The demographic data of the participants are presented below (see Table 3).

Table 3 - Profiles of participant teachers

Participants	Academic Education	Teaching Time (years)	Age (years)
Participant 1 - Paulo	Mathematics	Between 1 and 5	21 to 29
Participant 2 - Roberto	Mathematics	Between 6 and 9	30 to 39
Participant 3 - Jessica	Chemistry	Between 1 and 5	21 to 29
Participant 4 - Silvio	Chemistry	Between 1 and 5	30 to 39
Participant 5 - Fabricio	Mathematics	Between 1 and 5	21 to 29
Participant 6 – Joana	Mathematics	Between 6 and 9	30 to 39
Participant 7 – Emanuel	Biology	Between 5 and 9	30 to 39
Participant 8 – Fabio	History	Between 5 and 9	30 to 39
Participant 9 – Carol	Mathematics	10 > more	40 to 49
Participant 10 – Ana	English	10 > more	40 to 49
Participant 11 – Gilberto	Geography	10 > more	30 to 39
Participant 12 – Felipe	Informatics	10 > more	40 to 49

Source: The author (2022).

The following exclusion criteria were established: (a) participants who remained unwilling or refused to sign the consent form; (b) respondents who either deliberately provided false answers or who responded to less than half of the survey items. We also asked fellow researchers if they knew any of the teachers who met the inclusion and exclusion requirements in the sampling process.

The teachers had different backgrounds, times of teaching experience, and ages. Participants 1 through 8 co-created in the participatory workshop, and 9 through 12 participated in the low-fidelity prototype situated manipulation.

3.3.2 Situated Participatory Design

The participatory design process began by holding a stakeholder's workshop (KAPLAN, 2017) with basic education teachers. During the sessions, we collected narrative interviews, created a menu of ideas, prototyped artifact versions, and reflected on the proposals presented.

3.3.2.1 Creative Workshop

First, we held three creative workshop sessions, two with 2 teachers and the third with 4 teachers in the same gathering, totaling 8 teachers. The theme was the registration unit for content analysis, which includes the coding and creation of categories (BARDIN, 2011). Based on themes, we categorized data and created a low-fidelity prototype of groupware to mediate lesson planning activities. Narrative interviews realized during the sessions enabled us to obtain evidence that corroborated findings in the literature, and the reported situations experienced by the participants.

Preparation: Initially, the objective of the virtual event was presented to the participants. During each co-creative session, teachers were asked to answer the following questions individually from the episodic interview: (i) Going back in time, when did you ever prepare your class at home or at school? (ii) Could you give me an account of this experience? (iii) How do you link artifacts/people/emotions with regard to lesson planning? (iv) In the near future, what do you hope to improve regarding your

lesson planning? (v) How do you usually share your experience and digital educational resources with other teachers?

The group activities strived to stimulate creativity and collaboration, fostering the creation of innovative solutions.

Ideation: In the ideation session, the participants received a link to Google Presentations, where they saw the technique guidelines in the Menu of Ideas. After prototyping, each participant took a photo of their design and uploaded it onto the slide. Participants were invited to comment on their designs and freely discuss designs created by other teachers. Producing a Menu of Ideas enabled us to generate ideas for the project under study.

After this, the participants were guided to participate in the composition of the solution, creating and sharing alternatives for the design presented, through prototyping by producing sketches.

Prototyping: The researchers evolved the design solution with the data collected from the focus groups through data triangulation (participatory workshop + previous research + researcher contributions) to match the perceptions of the participants through the generated ideas. Prototyping enables us to obtain the representation of a story visually, through static frames produced through drawings.

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3.3.2.2 Prototype Situated Manipulation

In the second section, teachers performed a free exploration using the low-fidelity prototype and thinking aloud. After this, they performed three situated acts: (i) they created a traditional learning experience, invited a teacher to collaborate, and added an attached file; (ii) they created a dynamic learning experience by inviting a teacher to collaborate; (iii) they researched a French Revolution learning experience and began the encounter.

Creating a ‘traditional lesson plan is able to support teachers in creating lesson plans in a more familiar, conventional format, where users may invite other teachers to co-build, in addition to digital media such as images, videos, and links from outside environments.

A ‘dynamic lesson plan corresponds to an environment in which teachers are free to develop their lesson preparation with the necessary granularity and accessible representation according to their educational objective. This facility is represented as

a whiteboard with almost infinite borders. The functions permit and support innumerable future scenarios to co-create learning practices, projects, and activity performance.

Lastly, a narrative interview was conducted using the following questions (a) With regard to unstructured and non-sequential dynamic planning, could you comment on its use in future scenarios? What is the purpose of this interaction, by exchanging experiences and digital educational resources with other teachers? (b) How do you think the program could help record experiences and resources over time? (c) How do you think the platform can help you in your daily life? (d) Do you think the platform can encourage creativity and innovation in your teaching work? (e) There are many unforeseen events at school. Do you believe that the platform could help you to mediate or anticipate this type of event? (f) How did you feel when testing the prototype? (g) What did you like or dislike? Why? (h) Is there anything I have not asked about the subject that you would like to add?

All audio and video data were transcribed using the oTranscribe (https://otranscribe.com/) transcription tool and analyzed using the ATLAS.ti tool (https://atlasti.com/). The project results were developed in a navigable prototype format, available in the Figma tool.

They made their inquiries via WhatsApp® messages. They asked their colleagues whether they would like to collaborate in the research, with answers to a semi-structured interview, an agreed day, and at a time that best suited the interviewee. These interviews were conducted online, via Google Meet, for between 1 and 2 hours. The collection period took place between April 5 and August 26, 2021. The sessions were recorded so that the researchers could carry out data analysis retrospectively. A researcher was the mediator of the groups.

3.3.2.3 Data Analysis

Lave (1988) defines the unit of analysis for situated action as "the activity of persons acting in a setting", and the length of analysis is the relationship between the person and the setting. A setting is delimited as "a relation between acting persons and the arenas in relation to which they act." Considering that we intend to project a future solution with and for teachers, we need to pay attention to the flux of ongoing action to unfold actual activity in a natural setting (Ibid.).

Audio and video data collected during the co-design sessions were analyzed using content analysis to examine the manner in which the participant interactions and the software were composed (BARDIN, 2011). Lastly, teachers were invited to arrange another time to manipulate the results consolidated in a low-fidelity prototype version.

The categories were created by the researchers who authored this study and reflect the desire of the participants for facilities. These emerged from the analysis and reflections carried out from the collected data (MERRIAM; TISDELL, 2015). Therefore, the following methodological criteria were acknowledged during data analysis (BARDIN, 2011). The categories of facilities and their respective number of features were: collaborative space (9), digital notebook (9), digital calendar (7), digital library (7), educational news blog (3), teacher community (8), questions database, learning experience and notes (3). This data was synthesized in order to consolidate it and verify any overlap of data and its relationship with the object of study.

Data categorization made it possible to associate functionalities with the design recommendation of a collaborative system that mediates classroom planning activities. The groupware design recommendations were: (GDR1) Action-reflection-action practices; (GDR2) Constant unpredictability, contingencies and creative improvisations; (GDR3) Unstructured and non-sequential collaborations; and (GDR4) Seeking inspiration for creativity and innovation.

The concluding part of this data analysis was to conduct a free, open survey of tools that offered inspiring technologies for the low-fidelity prototyping of the collaborative system. Prototyping was based on the Lesson Plan Information System (QUEIROS et al., 2018). We also performed a benchmark analysis using the free exploration of educational tools that have correlated functionalities to the purpose of this study, such as Reddit (https://www.reddit.com/), Facebook (https://www.facebook.com/), Notion (https://www.notion.so/), Teacher Portal (http://portaldoprofessor.mec.gov.br/), Stack Overflow (https://stackoverflow.com/), Miro (https://miro.com/), Teacherly, Google Drive (https://drive.google.com/), Chalk (https://www.chalk.com/planboard/), Proedu (http://proedu.rnp.br/), and Teacher Pay Teacher (https://www.teacherspayteachers.com/). The tools were explored through the prior knowledge of the researchers.

3.4 RESULTS AND DISCUSSION

In the following sections, we present the main results from the participatory design and analysis of situated co-creation and collaborative lesson planning, alongside situated knowledge sharing and the reuse of digital educational resources.

3.4.1 Ideating and Sketching with Teachers and the Evolution of the Model

During the co-creation section, teachers were invited to handle, criticize and advance ideas related to possible future solutions. The debates were stimulated with a low-fidelity prototype, with which they were able to experiment to identify characteristics and offer fresh insights. The ideas proposed by the teachers were large and generic. For example, one solution that some of them suggested was a kind of social network for teachers where they could share experiences and digital educational resources. This kind of contribution indicates a kind of platform. Notwithstanding, in terms of functionalities and the mapping between essential needs and functionalities, they did not clarify what was to be designed. The same occurred when teachers proposed something in order to reduce the bureaucracy of the teacher's work and to participate in maintaining educational events for teachers.

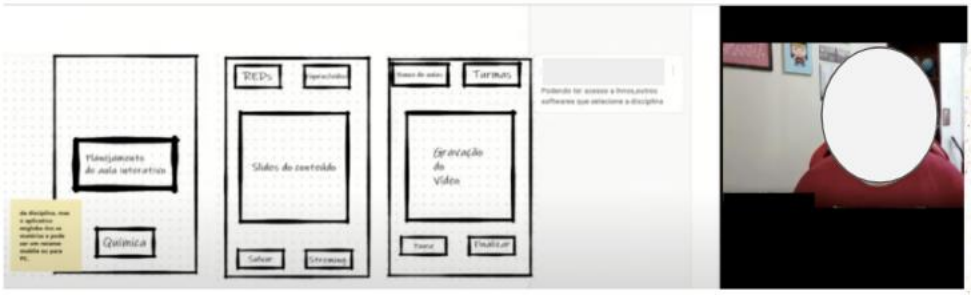
At this moment of the ideation section, all participants commented and reflected on what they had written. Ideas such as these are interesting for engaging participants in the proposal to compose, but are not informative or productive regarding value and functionality.

Sketching with and for teachers proved to be significant. Producing illustrations allows what has been written in the previous step to be complimented. In addition, it allows teachers to externalize what was not yet possible to be easily expressed through words. Thus, teachers elaborated groupware proposals that would allow them to carry out activities related to the preparation of collaborative classes.

Participant Jessica described the meanings present in the drawing she had created (see Figure 10). She stated that, “Overall, this would be an environment into which it would be possible for a teacher to put this content and its resources. So that there is no need to search other sites and other places.” The teacher discussed the importance of the system in a future work scenario with both the participants and the researcher. The teachers agreed that the device allows for searching, finding, and

using content created by the teacher. Moreover, the tool enables access to content from other repositories in the same environment.

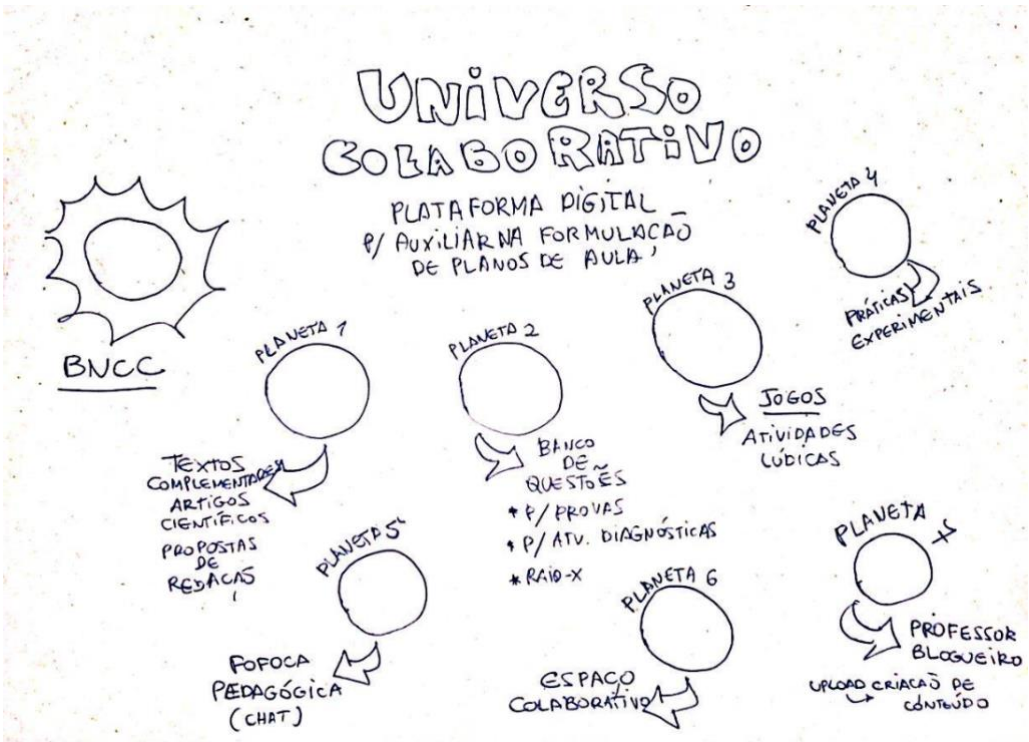
Figure 10 - Participant discussing the meanings presented in the sketch she created



Source: The author (2022).

Teachers use ordinary terms to represent the intentions of the system. Here it was as planets. Each of the seven planets corresponded to a set of features. For example, Planet 4, corresponds to space for writing and exchanging experimental practices. Planet 2 represents an environment where it is possible to have a database of questions, which would help them to practice exam preparation and diagnostic and x-ray activities. In Figure 11, the illustrated teacher designed a collaborative universe of lesson planning.

Figure 11 - Sketch of a collaborative system



Source: The author (2022).

The spaces represent the situated environments of a common teacher. The daily necessities are evidenced in the teacher's sketches, such as Planet 6, which is a collaborative space for teachers, where it is possible to share knowledge and digital educational resources, promoting individual and group professional growth. Teachers argued that they have a real necessity for professional development.

3.4.2 The Iterative Prototype Evolution

This section presents how teachers and researchers created many ongoing circles of interactions to evolve the conceptual model. We built low-fidelity prototypes of the Collaborative Space, Digital Notebook, Digital Agenda, Digital Library, Educational News Blog, Teacher Community, Question Bank, Learning Experience, and Reports categories based on the participatory design by teachers. We discussed how future digital possibilities could emerge from such a design practice. In addition, we correlated the functionalities with the design recommendations of a collaborative system that mediates classroom planning activities: (GDR1) Action-reflection-action practices, (GDR2) Constant unpredictability, contingencies and creative improvisations, (GDR3) Unstructured and non-sequential collaboration and (GDR4) Seeking inspiration for creativity and innovation. The following are short descriptions of the prototype features. Below is the summary of data triangulation, describing the relationship between the categories created with features, evidence, and soft goals (see Table 4).

Table 4 - Groupware evidence-based design

Categories	Sources	Evidence samples	Corresponding GDR
Collaborative Space	Experience and content forum. Chat.	Emanuel sketched a space for teaching-learning and collaboration among teachers (see Figure 2).	GDR1, GDR2, GDR3 and GDR4
Digital Notebook	Digital note	Silvio said, "The notebook. I take the remaining paper, bind a hundred sheets, and record on them as my subjects. For example, there is an organic chemistry notebook and a physical chemistry notebook because just that will just help me."	GDR1, GDR2, GDR3 and GDR4

Digital calendar	Personal and school calendar	Paulo said: “It stays in my mind, but also in the curriculum itself, I already sketched in the dates of the school calendar in the content section. This is the way for me to lead and not to overdo things, or to be repetitive, and also of not getting behind in my progress.”	GDR1, GDR2, GDR3 and GDR4
Digital library	Curator of Digital Educational Resources	Silvio said, “The possibility of dissemination as a social network, one that shares ideas and works among teachers” and access to textbooks in certain areas (easy search for content to find what was free).	GDR1, GDR2, GDR3 and GDR4
Educational News Blog	Education News and information	Emanuel described the creation of a tool for sharing scientific texts/news/complementary readings.	GDR3 and GDR4.
Teacher community	Public profile and knowledge building among peers	Joana described: “A teachers' social network (like an Instagram of practices and tips).”	GDR1, GDR3 and GDR4
Questions Database	Evaluative exam questions	Paulo reported: “Ready-made activities, like a quiz that the teacher selects and already sends to his students. A database of questions by theme.”.	GDR1 and GDR4.
Lesson plan	Traditional and Dynamic lesson plan	Roberto stated that: “We (the teachers) take the resume that already comes with the proposed skills and content. I take this material, which is to be given throughout the year, because the math content is pretty extensive, so I include all the dates. I don't make a lesson plan for each class because of the time involved, there’s just no time to make that plan. In this case, the State has specific classes for this, but we take advantage of these classes just to make another connection, but some of them are mandatory in the classroom, so we manage to plan on a weekly basis, not so much per class. So, we set up this scheme at the beginning of the year, and it begins to mold over time. As the classes move on, so this adapts to the classes.”	GDR1, GDR2, GDR3 and GDR4

Notes	Personal, system, or peer activity reports	Jessica said: “A memory register of what I've worked with. I don't know if it works for every discipline. It works for chemistry because, for example, the types of reactions are organic, you see! Yeah, when we were there with mine, I asked how he managed to memorize so many organic formulas because the content is gigantic. And then he showed me his materials, the books, and he said that making these records with all the content would help him in another discipline.”	GDR1, GDR2, GDR3 and GDR4

Source: The author (2022).

The user journey starts on the Home page, where the initial concept and functionalities of the collaborative system are exhibited. It is possible to contact previews with learning experiences and read how the user may optimize time using the solution. This is the page for registering a new user or entering the platform.

We proposed facilities so that each teacher has to have both a private and public profile for the community. In the private profile, the teacher may have resources that other teachers cannot see. In the public profile, all other teacher users can see the resources that have this open-access setting.

Each teacher has a personal page where his/her public resources are displayed. In addition, all teachers may enter professional information or any other information they consider to be pertinent. If it is of interest, this information and resources may be considered as a professional portfolio.

Teacher participation created appropriate dynamics for the discussion and construction of knowledge and the development of the conceptual model of the solution. Initially, we proposed a design based on the needs discovered in a deep participatory phase. We intend to evolve the conceptual model from the participatory study (DOURISH, 2006). We used an initial conceptual model as an artifact to create and design with participants.

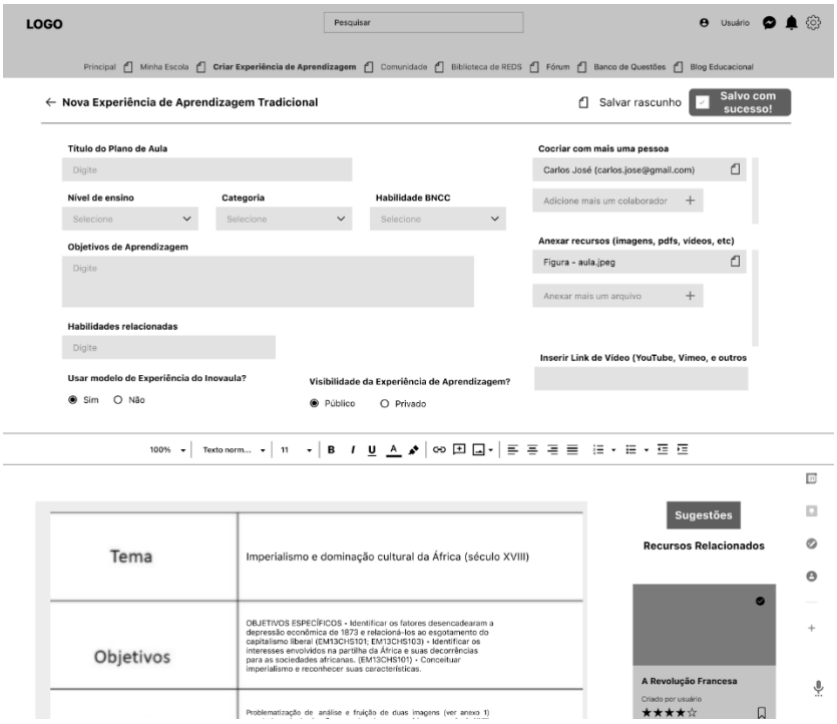
3.4.3 Situated Prototype Manipulation

Creating a lesson plan is one of the numerous activities that is necessary for class preparation. As discussed in the recent literature, for various reasons, this activity often occurs solely for bureaucratic purposes.

In the second section, teachers performed a free exploration using the low-fidelity prototype and thinking aloud. As plausible future teacher scenarios, they: (i) Created a traditional lesson plan (See Figure 12), invited a teacher to collaborate, and added an attached file, (ii) Created a dynamic lesson plan by inviting a teacher to collaborate. There are different features to support these two pursuits, as will be described below.

Thus, a virtual environment was prototyped that attempted to reproduce an adequate space for creating a learning experience, which is possible to develop according to the interests and teaching approaches desired by the teachers.

Figure 12 - Feature created traditional lesson plan (Low-fidelity prototype)



Source: The author (2022).

Felipe manipulated the prototype, simulating a possible future scenario. He said, “Title of the experiment, introduction to the database. Conceptual database, relational database, this one is cool. Level of education, technical high school, integrated high school, and so on. Database, introduction to the database, the competence of BNCC, there... Now. Skill, knowledge in database, co-creating with one more person. Yes, I could share it with another teacher who has this discipline and this class. That would be great, that would be great, to do that with another teacher. This would be excellent. I would put Henrique here, and it will be there in the future.”

Such perception was optimistic with regard to using the system in a collaborative environment with a teacher who teaches the same subject (PATTON; PARKER, 2017). The two can co-create a lesson plan, reuse educational resources, and thereby eliminate the loneliness of isolated practices. Hence, it becomes a moment of digital presence (PINK, 2015).

Gilberto envisions a future scenario for using the dynamic learning experience, “for example, we work with planning, workshops, working with dynamics, working with educational excursions. You need to do multidisciplinary work, such as geography, history, sociology, and visiting - for example, the Catimbau Valley. So, you will study the geographic, historical, sociological, and anthropological questions of that community there so many years ago, you see! So, it is certainly essential to have a platform that addresses this need.”

The authors themselves believe that such a space may be used for countless educational scenarios. It is possible to create lesson plans in an accessible format to meet the necessities of teachers. It is possible to make video calls between teachers registered in the groupware, insert images, create a mind map, and post notes, among other digital resources that support class preparation activities. The anticipated space is almost contrary to traditional creation, which, as we have seen, is created for formal specifications of the educational system, having minimal use and meaning for the current practice of class preparation.

The ‘My school’ facility is an appropriate space and permits organizing, collaborative (or not) creation, and classifying documents into notebooks by educational institutions. It also has an organizing calendar that classifies the monthly events, where users may add more events and manage them. In this area, users may share learning experiences, notes, and other documents through QR-code, a feature designed to reduce the impact of unpredictability and bring dynamism to the teacher's experience. Teacher Ana mentioned the importance of digital notes in the present and future: “Regarding the use of notebooks for teachers, we already have to do as many things as possible digitally... so for those who are usually taking notes, etc., it may be helpful when you are going to make a lesson plan, for example.”

Teachers may organize their files as they wish. However, we understand that the system can support the teacher with organizational suggestions, whether through schools, archives, or any other element of basic education.

The ‘Digital Educational Resources Library’ is a kind of storage place for digital educational resources. Resources are created by the community of teachers, in addition to those that are indexed from platforms that provide open educational resources. It is possible to reuse and share the results via user experience and with other teachers. The search allows results to be filtered by grade level, file type, and peer review rating.

The ‘Question Database’ is the storage environment for evaluation sources, such as questions, quizzes, tests, simulations, and essay topics. It is possible to filter the available questions by discipline, content, and topic. There is also an option for adding this evaluative content to new learning experiences created on the platform, making the preparation of tests more straightforward.

3.4.4 Knowledge Sharing and Reusing Digital Educational Resource Facilities

One constant challenge lies in seeking and selecting digital educational resources that may be applied to various school contexts. This arrangement may be supported by an environment where teachers are able to receive peer assistance.

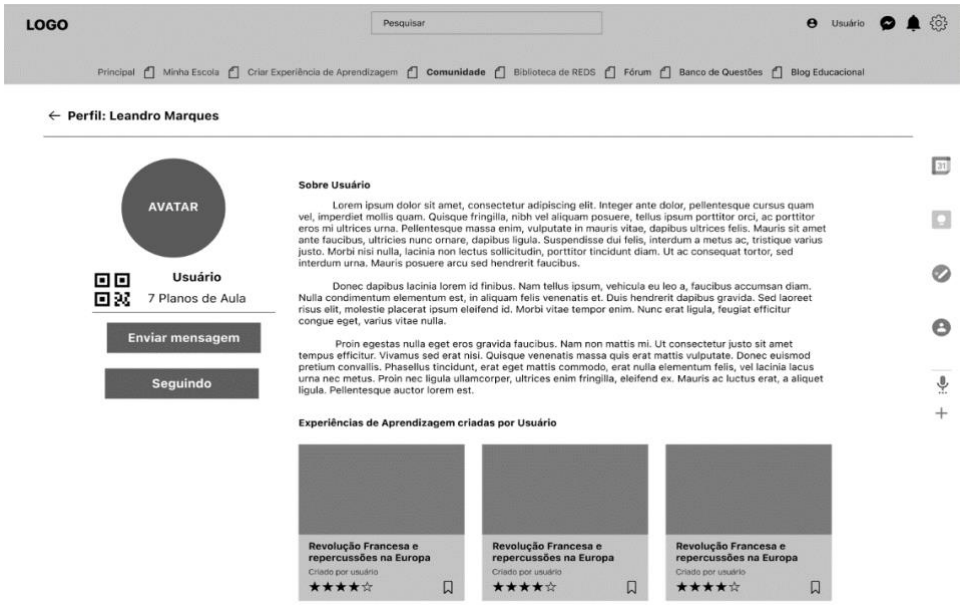
This second theme is related to question (iii), Research a French Revolution learning experience and opens the experience. There are several ways to research an educational resource, such as reuse, conducting a search in the teacher community, or knowledge sharing in dialogue with another teacher by text, video, or audio message. Search in the library of digital educational resources makes it possible to find sources stored in different repositories of open learning objects and academic texts (OTTO; KERRES, 2022).

The ‘Teacher Community’ is the environment for teachers enrolled in the collaborative system, where their learning experiences and resources may be shared. This space is intended to provide an opportunity for relationships between peers. Such connections may be initiated via the teacher profile, learning experience, and peer review verification on their learning experiences (ESHCHAR-NETZ; VEDDER-WEISS, 2021). When taking the prototype test, Felipe mentioned the teacher community, stating that "Yes, if they are part of my community, I can, I can start a subject, I can put in a subject, it's a form of communication, communication will always be positive. And here the tool provides conditions, here, look, here, message, search for people, so these people may not necessarily be doing this planning, but they may be

consulted." The teacher realized the value of being able to collaborate in a community with different goals. This is a space where it is possible to exchange experiences, reflect on other people's practices and imagine future scenarios.

By navigation, it is possible to start collaboration, message exchange, reuse, and favor a specific teacher so that users may follow new interactions selected for a topic that is of interest to both parties. This search allows results to be filtered by grade level, file type, and peer review rating (See Figure 13). The teacher said, "Yes, it has a positive impact. It impacts positively. I can look for it there. I can use something that I have already created before. It's good, it's good, it's always good. It's something we always do. Searching on these platforms, you can reuse something and edit a few tweaks, which is something not to do from scratch. He saves it, but it seems for the most part he doesn't want the guy to reuse it. It seems that people like to slaughter, see you do it from scratch. This is good. Sharing and reuse are good. I liked it." Felipe highlighted the significance of reusing digital educational resources. Having a search system and reusing material from another teacher will undoubtedly impact his class preparation work.

Figure 13 - A teacher's profile page, with experiences rated by other teachers (Low-fidelity prototype)



Source: The author (2022).

When carrying out the prototyping, the collaborative space was remodeled and designed to enable users to clarify doubts and answer questions that users share on the platform. Gilberto gave his perception of this environment for exchanging

information and experience, “It's cool, man. You can talk to people, and see answers. You can talk a lot. You can get a lot of information here. Staff suggestions. Excellent!” Users themselves may choose which answer is most suitable for a question, and receive more comprehensive answers using the related questions.

To present the essential contents, the answers to the questions may be classified to illustrate a contribution or non-contribution. Only those that were positive would indicate the number of interactions that had been performed.

Direct messages and Informs are spaces designed for exchanging experiences and resources synchronously and asynchronously. Exchanges may be made via text, audio, or video, and privately. When performing a communication, a notification of interaction in the system is generated, creating an alert for the user related to the issue. The collaborative system may dynamically generate new messages and notifications.

The ‘Educational’ Blog features news created and shared by the platform teachers (ONYANGO; GITONGA; RUGAR, 2017). It is also possible to share such news in private messages. Asked about his perception of an ‘Educational Blog’, Gilberto stated that “I think it's cool. I understand that it's a blog that will have information for my daily school life. To help prepare classes. To gain information about news around education.” The blog writers curate the collaborative system and help bring relevant information from the universe of education.

In the final section, we explore the research question: how do basic education teachers perceive sketching low-fidelity prototype co-created groupware? We also discuss how interactions through the low-fidelity prototype reveal new insights on the collaboration among them and guide the design of the groupware tool intended to mediate class preparation and knowledge, along with the interchange of digital educational resources.

3.5 FINAL CONSIDERATIONS

The main objective of this study was to investigate the situated participatory design of low-fidelity prototype co-created groupware and reveal new insights on the collaboration among participants, guiding the design of the groupware tool. In this article, we have presented a study whereby a prototype was co-designed to concretize how groupware may be part of collaborative class development activities.

A participatory design study with a qualitative approach was conducted. Data were generated from a creative workshop, from which it was possible to propose nine categories of data analysis. These data were triangulated (participatory workshop, literature, and researchers' contributions). A prototype of situated manipulation was conducted on a collaborative system co-created with basic education teachers, who were not the same as the ones who had engaged in the participatory workshop. Hence, this situated manipulation presented results that corroborate the data generated in the participatory phase, the suggested data categories, and soft-goal validity for collaborative systems measuring classroom planning practices.

The idea has provided teachers with a basis for prototyping possible solutions, such as digital solutions (PINK, 2021), better school infrastructure, continuing education, internet access, etc. At the same time, the interactive prototype has provided them with possibilities to visualize themselves in the future using groupware as an artifact that is able to support their classroom preparation practices.

The foundation for the prototype was knowledge and experience regarding the collaborative lesson plan. The prototype aimed to clarify how teachers could create, reuse and share knowledge and information with teachers in an isolated context - limited by a lack of training and inadequate infrastructure - with co-designed groupware.

The prototype simulated a possible future device so that teachers could collaborate and use it as a mediating artifact for preparing their lesson plans in their future work. The paper has demonstrated that the features co-created and simulated in prototypes may be used in collaborative lesson plan practices.

We have demonstrated that the situated prototype manipulation and the participatory design approach are new to teachers. We consider that the seaworthy prototype navigation was limited in terms of situated experiences. The artifacts need to be more interactive in order to give a more realistic experience of preparation for a collaborative educational experience, or software developed with the basic features essential to the study.

The study also examined the situated actions of teachers regarding the collaborative system that supports the sharing of knowledge and educational materials. The research outcomes have addressed how the qualitative approach to participatory design may promote solutions for future collaborative systems in work on collaborative classroom planning. Thus, the study introduces new opportunities to confirm, assess

and gain new insights into using the features in groupware, which may contribute greatly to understanding how solutions co-designed with the teachers may be assertive and illustrate their fundamental necessities. In this sense, we ask how the teacher perceives interchangeable knowledge and planning practices mediated by adopting groupware.

4 THE IMPACT OF A GROUPWARE LESSON PLANNING SYSTEM ON TEACHERS' WELL-BEING

4.1 INTRODUCTION

Well-being has been the subject of studies for decades by encompassing the components of affect and cognition (OSTROM, 1969; DIENER et al., 1999; SCHIFF et al., 2021) in physical and digital environments. In the educational context, the search for promoting subjective well-being in the activities developed by teachers is a constant practice in didactic and pedagogical studies and procedures (HAKAMI & HERNANDEZ-LEO, 2021; OLSZEWSKA, 2021; SAASTAMOINEN et al., 2022).

Subjective well-being is essential for human development (WAGNER et., al, 1999). The concept of well-being adopted in this study is "The continuous and sustainable physical, mental, and social flourishing of individuals, communities, and populations where their economic needs are cared for within a thriving ecological environment." (IEEE, 2020, p. 19).

The IEEE (2020), proposes well-being metrics to enable designers to know how the products and services created can impact well-being, based on a broad spectrum of measures, which range from affect, collaboration, and work to psychological well-being.

Wiese et al. (2019) argue that technology design and products contribute to people's well-being. The contribution is in its potential to create artifacts that can support activities that improve the well-being of individuals, and not in its material value. Duque et al. (2021) complement by arguing that design can support or enable positive and meaningful activities for people.

4.1.1 Educational Technologies

Creativity, digital literacy, collaboration, and communication are some key 21st century skills needed for professionals to succeed in their professional activities, but to do so one must have time available to develop them (LEMKE, 2002; VAN LAAR et al., 2017; CHALKIADAKI, 2018; DISHON; GILEAD, 2021). These skills can be developed and established from educational teaching-learning planning.

The availability of Digital Information and Communication Technologies in education has become fundamental in the development of teachers' digital skills (Hökkä & Eteläpelto, 2014). When adopted effectively, it provides an intensification and improvement of planned pedagogical practices (OLIVEIRA; MOURA; SOUSA, 2015; CARDOSO ALMEIDA; SILVEIRA, 2021), as they can generate diverse teaching-learning experiences. However, the use of TDIC in classrooms is unique to each context of teachers, particularly due to the teachers' TDIC training needs to master TDIC and the low levels of collaboration between teachers (GIL-FLORES; RODRÍGUEZ-SANTERO; TORRES-GORDILLO, 2017; POWELL; BODUR, 2019).

For this collaborative work context, groupware type tools are recommended as an alternative for supporting group work. The proposal allows people to collaborate connected to computer networks in order to perform tasks together toward established goals, whether or not they are in geographically distinct locations (TARRAG; HOPPEN, 1999).

4.1.2 Purpose of the Study

Over the years, the United Nations Educational, Scientific and Cultural Organization (UNESCO) and many countries have been motivated to contribute and knowledge about the factors that influence the sharing of knowledge and digital educational resources among teachers in basic education (UNESCO, 2022; DIMITRIADIS et al., 2009; SILVA et al., 2016; HITZSCHKY, CASTRO FILHO, FREIRE, 2020; MEDEIROS et al., 2021). Based on the literature on collaborative lesson planning and lesson planning tools, and a sequence of field studies performed (previous sections), we propose a set of design recommendations for groupware development that support knowledge and resource sharing, educational and participatory groupware design.

In the context of this research, we analyzed the domains of affect and well-being for community and work. The literature indicates that the sharing of knowledge and digital educational resources among teachers cannot be fully understood without considering these issues (OTTO; KERRES, 2022).

This study seeks to assess the level of preceptors' perceived well-being when using a groupware prototype that supports knowledge sharing and educational resources.

Therefore, we asked whether well-being could be improved by adopting CLP groupware. This considers that there are limitations and challenges in the mediating systems of collaborative classroom planning activities (MOR; CRAFT; HERNÁNDEZ-LEO, 2013; ERADZE; RODRÍGUEZ-TRIANA; LAANPERE, 2019; QUEIROS et at., 2019; ZALAVRA et al., 2021). The answer to this question may contribute to the literature in that it will inform the level of well-being of these professionals perceived in the groupware that supports their craft, especially lesson planning activities. Therefore, well-being is the primary construct. Thus, we formulated the following research question: How can a collaborative lesson planning groupware impact teacher well-being?

To answer the main question, this study proposes to answer the following research questions:

(i) What levels of **affect** are aroused in teachers, and how do these affect correlate, particularly when doing collaborative lesson planning activities in groupware?

(ii) Which **Community** indicators have the most impact when doing collaborative lesson planning activities in groupware?

(iii) Which **Work** indicators have the greatest impact when performing collaborative lesson planning activities in a groupware?

The paper is organized as follows: in section 4.2, we describe the methodological approach, data collection, and analysis procedures. The main results are presented in Section 4.3, where we highlight the evidence of the main findings. Finally, in Section 4.4, we discuss the important results, implications, and limitations of this study.

4.2 METHOD

In this paper, we adopt a projective research paradigm (NELSON; STOLTERMAN, 2012), which allows us to advance knowledge about the new desire for knowledge to be designed by proposing transformations on an evolving artificial artifact (HEVNER; CHATTERJEE, 2010).

This research is qualitative and quantitative (APPOLINÁRIO, 2016). We use quantitative data generated from the responses of the survey applied to the participants. The qualitative data was generated from thinking aloud when using groupware.

4.2.1 Participants

Thirty teachers participated in our investigation (see Table 5), ten female (33.33%) and twenty male (66.66%), distributed among fourteen municipalities in the state of Pernambuco (Brazil). About four (13.33%) of these teachers have up to 4 years of teaching experience, and twenty-six are specialists (86.66%).

In the sampling process and test plan (NIELSEN, 1994; GOODMAN; KUNIAVSKY, 2012), inclusion criteria were considered: a. being a school teacher in public education; b. being willing to voluntarily participate in the research; c. having a personal computer to access the Internet and test the prototype via browser in the Figma tool.

For the study, the following exclusion criteria were defined: i. participants who did not want or refused to sign the consent form; ii. respondents who deliberately provided false answers or did not respond to more than half of the survey items. We asked fellow researchers if they knew any teachers who met the inclusion and exclusion requirements in the sampling process.

The author researching asked other researchers for indications of teachers who are included in the research profile. They made inquiries via WhatsApp® messages. These then asked their colleagues if they would like to collaborate in the research. The recruited teachers teach various subjects, such as: mathematics, biology, physics, physical education, geography, among others. The data was collected between the months of January through March 2022.

The demographics of the participants are below. Names below are changed so that participants cannot be recognized or identified.

Table 5 - Profiles of participating teachers

Participants	Academic Education	Teaching Time (years)	Age (years)
Participant 1	Experimental Sciences and Practices	0-3	18 to 25

Participant 2	Informatics, Technical Base for Development of Computer Systems and Networks	8-11	26 to 30
Participant 3	Math	11+	56 to 60
Participant 4	Arts, Geography, History, Philosophy and Sociology	11+	51 to 55
Participant 5	Math and Physics	11+	41 to 45
Participant 6	Physical Education, Geography, History and Math	11+	46 to 50
Participant 7	Physics and Math	11+	36 to 40
Participant 8	Computing	8-11	41 to 45
Participant 9	Math	4-7	18 to 25
Participant 10	Math	8-11	31 to 35
Participant 11	Math	0-3	26 to 30
Participant 12	History	11+	56 to 60
Participant 13	Math	8-11	36 to 40
Participant 14	Arts, philosophy	11+	41 to 45
Participant 15	Research Methodology Applied to Projects, Socioemotional Education, Learning Laboratories, Socioemotional Skills and preneurial Behavior; Integrating Project (Computer Networks), Structured Network Project	4-7	31 to 35
Participant 16	Informatics, Logic and Computational Thinking I, II, and III; Database	4-7	31 to 35
Participant 17	Math and Scientific Research	4-7	26 to 30
Participant 18	Computing, Completion of Course Work and Scientific Research	8-11	41 to 45
Participant 19	Math	11+	46 to 50
Participant 20	Physical	0-3	31 to 35
Participant 21	Geography, History, Sociology	11+	46 to 50
Participant 22	Portuguese Language, Multipurpose Teacher - Elementary School, Education of Young People and Adults (EJA)	11+	41 to 45

Participant 23	Various disciplines in the field of graphic design and communication	4-7	31 to 35
Participant 24	Arts, Foreign Language, Portuguese Language and Philosophy	11+	51 to 55
Participant 25	Math	0-3	31 to 35
Participant 26	Computing	11+	51 to 55
Participant 27	Physical	4-7	31 to 35
Participant 28	Taxes and Tax Documents, Quality Management, Integrating Project 2, Elective, Production and Operations Management, Life Project.	4-7	31 to 35
Participant 29	Foreign language	4-7	31 to 35
Participant 30	Arts, design and advertising	4-7	46 to 50

Source: The author (2022).

The measurements (section 4.2.2) were administered in online sessions via Google Meet (± 1 hour). The teachers were asked to direct their answers to one of the online Google forms (Appendix A**)**. They agreed to the informed consent form, which presented the research objectives, the researchers, their rights, guarantees that they would not be personally identified, and that participation could be stopped at any time without penalty.

4.2.2 Peasurements

4.2.2.1 Well-being

This study used the IEEE standard P7010–2020 'Recommended Practice for Assessment on the Impact of Autonomous and Intelligent Systems on Human Well-being', developed by Olszewska (2020). We used a 37-item questionnaire rated on a 5-point Likert scale (1. Totally disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agreed, 5. I totally agree) (Ibid.). It explored the three domains of well-being: affect, community, and work (APPENDIX A). The choice of domains was due to the strict relationship with the objective of the study.

Participants reported their perceptions (Likert scale) about well-being for the items (see Table 6) related to: affect, community, and work.

Table 6 - Well-being domain: affects, community and work

Well-being domain	**Survey items. Using the prototype can:**	**Variable**
Affect	makes me feel happy	FELI
	makes me feel sad	TRIS
	makes me feel calm	CALM
	makes me feel stressed	ESTR
	makes me feel frustrated	FRUS
Community	makes me feel like I belong to a community	PECO
	makes me feel that I am rejected by a community	NPEC
	increases the approximate total hours a month that I was involved in voluntary activities	AHAV
	makes me feel that if I were in trouble, I would have relatives or friends I can count on to help me whenever I need them	AJUD
	makes me feel that I can trust people	CONF
	makes me feel that I need to be careful in dealing with people	CUID
Work	increases my satisfaction with work	SATR
	decreases my satisfaction with work	DSAT
	makes me feel that my work life is interesting	VIPI
	makes me feel that my work life is uninteresting	VIDE
	makes me feel that my supervisors have respect for and care about my welfare	SBE
	makes me feel that I get help and support from my co-workers	AJCO
	enhances my work productivity	PROD
	increases my satisfaction with the balance between the time spent on the job and the time spent on other aspects of life	EQTE
	decreases my satisfaction with the balance between the time spent on the job and the time spent on other aspects of life	DEQT
	increases my satisfaction with the opportunities for professional development and promotion in my current primary job	DEPR

Source: The author (2022).

4.2.3 Procedures

The data collected was divided into two moments. First, the teacher was asked to freely navigate and manipulate the interface of the high-fidelity prototype. Next, the teachers were invited to perform five (05) tasks (see Table 7), which were defined as activities performed by the teachers.

These were: Search educational resources (Resource library), Create and Co-create traditional and dynamic lesson plans (Authoring tools), Reuse resources (Teacher community), Knowledge management (Practices, notes, and Reflections), Organization (Educational resources) and Time management (Calendar). The tasks of the digital well-being and attractiveness test are:

Table 7 - Task of the third assessment cycle

#	Tasks
T1	Search, open, and save an environmental sustainability lesson plan
T2	Create a traditional plan, with an image of Trees (illustrative figure)
T3	Create a dynamic plan with an image of Trees (illustrative figure)
T4	In Repositories, find and open an environmental sustainability educational resource
T5	Create a digital sheet and share with a teacher

Source: The author (2022).

During the test, participants were asked to think aloud (Nielsen, 1994). Data was collected by recording the computer screen and the participants' audio. Each task was completed when the participants considered that they had completed it or reported that they were unable to perform the task. No manual was made available for the participants to perform the requested activities.

The variables for task analysis were: time spent per participant to perform a task, the ratio between tasks performed correctly by the total number of tasks suggested for completion, the ratio between tasks performed correctly by the total time spent for completion, number of errors that occurred until the user considers the task completed, requests for help while performing the task, and total correct tasks.

In the second stage, the participants were asked to complete a demographic and well-being questionnaire. At the end, the teachers were able to make final comments on any aspects that they felt were pertinent to the test (OLIVEIRA, 2017).

3.4 Statistical analysis

An exploratory multivariate data analysis was performed (MOITA; MOITA, 1998; HUSSON; LÊ; PAGÈS, 2011). The data were tabulated and formatted in a spreadsheet editor, then descriptive statistical analysis of the data was performed using R software (TEAM, 2013).

We utilized the unsupervised linear principal component analysis method (PCA) to reduce the dimensionality of an input data set while ensuring that it preserved as much information as possible (NIKETBORADE, DESHMUKH, 2014). The goal of the PCA is to minimize the dimensions of the data set to obtain a set of principal components that explain the most significant percentage of the variability in the data (ABDI; WILLIAMS, 2010). Discriminant Analysis was performed, as the name implies, to discriminate and classify the participants into groups (JOHNSON; WICHERN, 2007).

Hierarchical and non-hierarchical methods were adopted in the analysis of the groups (RENCHER, 1997). The classification was obtained in order to make appropriate decisions and analyses for each group. The formation of the clusters is associated with metrics responsible for quantifying the similarity or dissimilarity between the observations. For the determination of the groups dendrograms were used (MURTAGH; CONTRERAS, 2012).

Where, the Euclidean distance with Average method was employed in the study, a measure of similarity between two clusters, where the distance between the clusters is taken as the average between two elements in each cluster.

In summary, the techniques utilized were (MOITA; MOITA, 1998; GIBBONS; CHAKRABORTI, 2014): Technique 0: Exploratory Analysis - Density, Correlation (to examine and study the characteristics of a dataset before it is submitted to an application); Technique 1: PCA (to analyze interrelationships between a large number of variables); Technique 2: Correspondence Analysis (to describe matrices with a large volume of discrete data and without a clearly defined a priori structure); Technique 3: Hierarchical clustering (to find patterns in a dataset); Technique 4: Non-hierarchical clustering - K-means method, Average (to group individuals where the variables are independent); Technique 5: Discriminative analysis (to see if a set of independent variables discriminates between groups); Technique 6: One-way ANOVA - Kruskal-

Wallis and Wilcoxon (to perform the comparison of three or more groups in independent samples).

The representation of the data will be presented in the next section through the analysis of the tasks, by means of graphs, and in some cases, analysis of well-being in relation to teaching time and frequency of lesson planning.

4.3 RESULTS AND DISCUSSION

4.3.1 Task Analysis

The tests were conducted with 30 participants. The proposed tasks were: (i) Search, open and save an Environmental Sustainability Plan (search and organize in resource library). (ii) Create and fill a traditional plan and add an image of trees (authoring and co-creation tool). (iii) Create and fill in a dynamic plan that will already have an image of trees (authoring and co-creation tools). (iv) In repositories, find and open an Environmental Sustainability Education resource (reuse resource from teacher community). (v) Create a digital sheet, fill it out and share it with another teacher (knowledge management of practices, notes and reflections). Initially, the tests were analyzed by an activity based on effort, effectiveness, efficiency, errors, help, completion evaluation and total correct tasks.

For activity (i) Research, open and save an Environmental Sustainability Plan (see Figure 14), all 30 (100%) participants completed the activity. Among them, there were 3 (10%) requests for help and 6 (20%) deviations in the course of the task. The average time to perform the task was 01 minute and eighteen seconds. The minimum time was forty seconds and the maximum time was two minutes and fifty seconds.

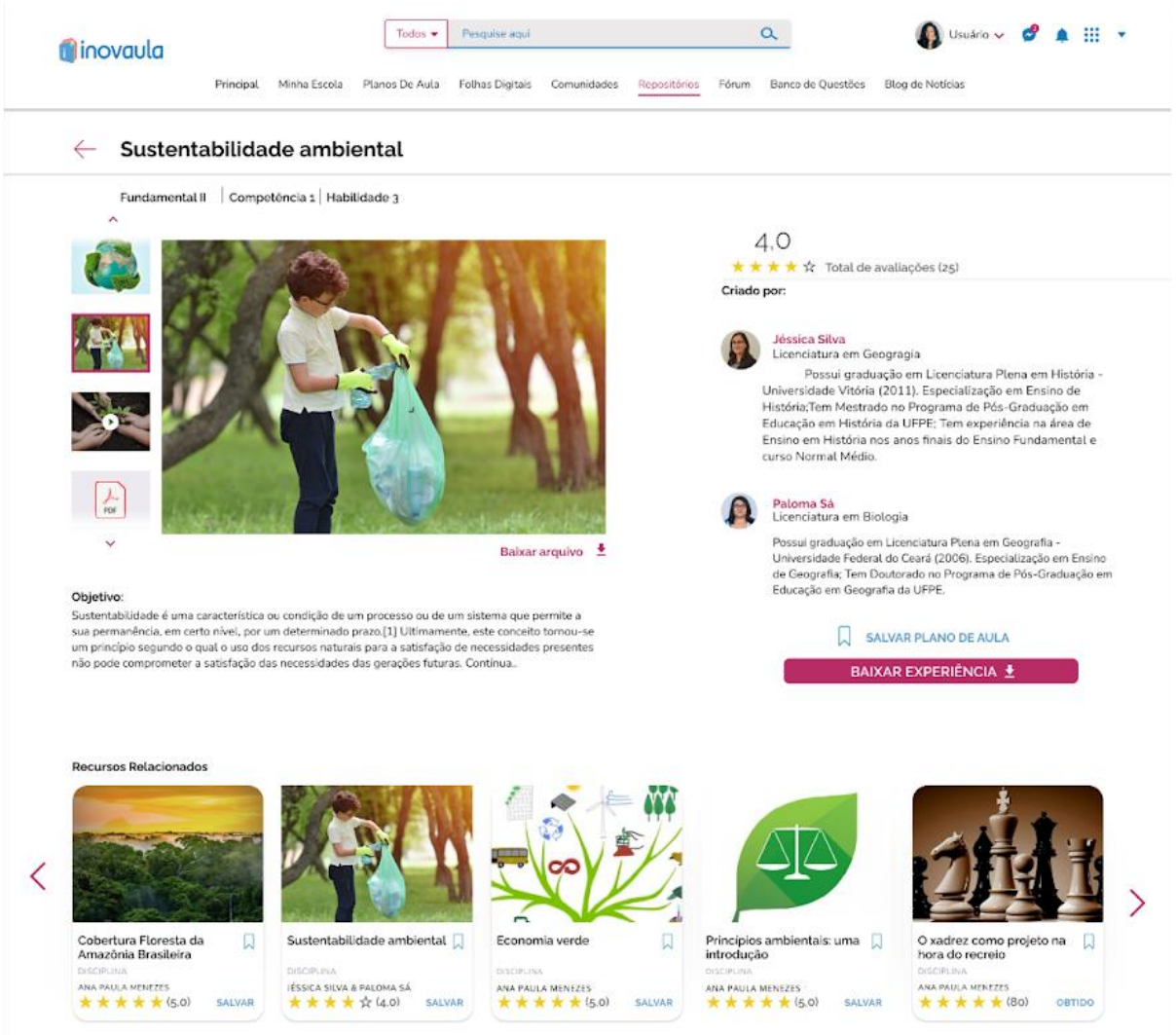
The participants demonstrated their perceptions of using groupware to accomplish activity (i). It was emphasized that the exchange of classroom experiences allows us to bring innovation and enhance teaching and learning. In addition, it was commented that the exchange between teachers is valuable, even for the sense of knowing who is correctly approaching a certain content.

From activity (i), it is possible to identify that the proposed design serves the purpose of supporting teachers in carrying out the activity. The availability of educational resources and communication channels in groupware helps teachers realize that they can help or be helped by the teacher community, in addition to

promoting increased job satisfaction. In this sense, it is understood that the relationship built between teachers can be presented as the construction of relationships of trust and belonging to a community.

After carrying out the task, suggestions were made and errors were identified in the prototype. It is worth highlighting the suggestion that when creating a copy of the lesson plan, it is worthwhile keeping a record of the author and who made subsequent changes visible. As an action plan, documentation of best practices in the use of groupware can be proposed, which involves transparency among users and descriptions of usage rights. The errors were related to the lack of interface feedback to users, such as feedback that the lesson plan has been saved to their plans and that a plan has actually been downloaded.

Figure 14 - Environmental Sustainability lesson plan screen (high-fidelity prototype)



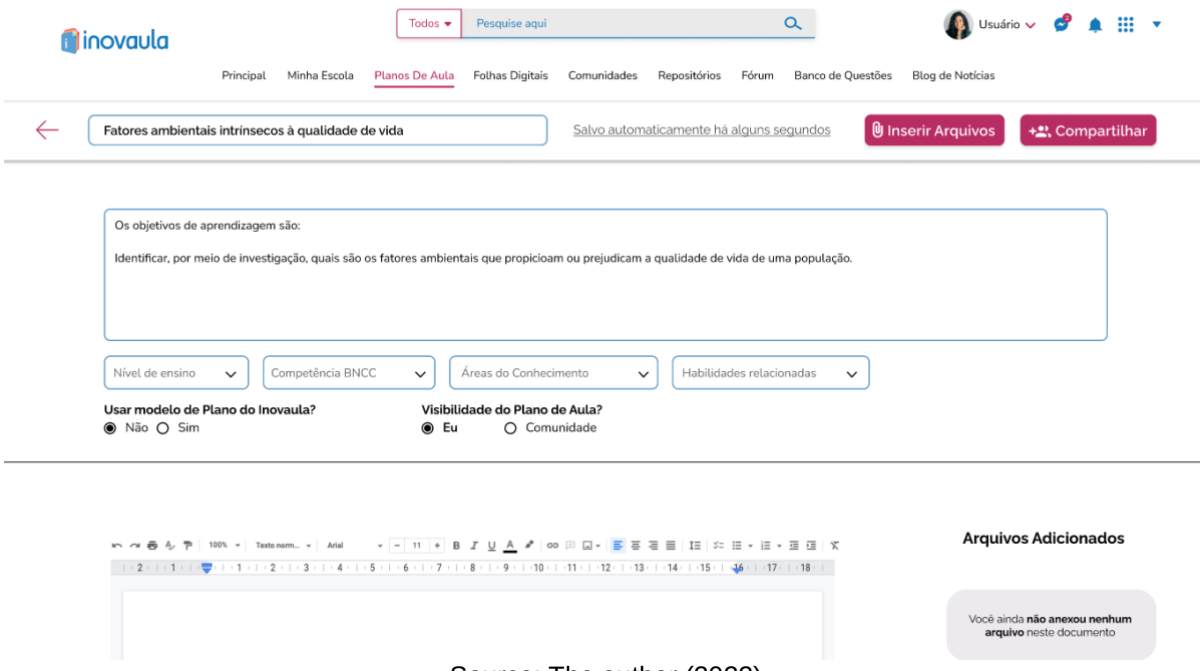
Source: The author (2022).

For activity (ii) Create and fill a traditional plan and add an image of trees (see Figure 15), all 30 (100%) participants completed the activity. Among them, there were 8 (26.7%) requests for help and 8 (26.7%) deviations in the course of the task. The average time to perform the task was two minutes and fifteen seconds. The minimum time was forty-eight seconds and the maximum time was five minutes and forty-five seconds.

The proposed design for lesson plan creation allowed the perception that they could perform the activity in a faster way than usual - to quote one teacher, "any gain of time allows you to focus on other things, new methodologies and even innovate in the classroom". The relationship between the creation of the lesson plan and the skills and competencies of the BNCC was indicated as relevant for planning. Resources in the same lesson plan creation environment may indicate reduced effort from external Internet searches.

Despite the completion of the activities, the participants presented difficulties in performing the activity due to the flow of screens and interaction with the prototype being limited to clients and pre-built sequences.

Figure 15 - Traditional lesson plan creation screen (high-fidelity prototype)



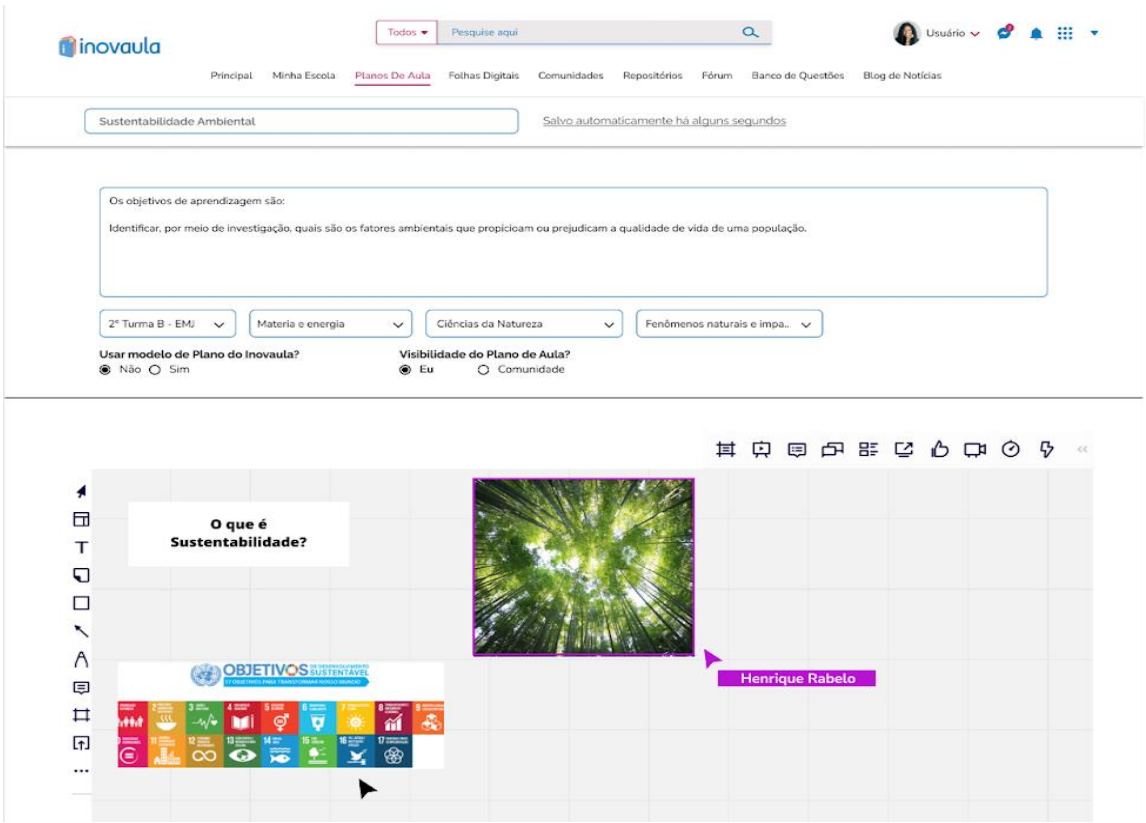
Source: The author (2022).

For activity (iii) Create and fill in a dynamic plan (see Figure 16) that will already have an image of trees (authorship and co-creation tools), the 30 (100%) participants completed the activity. Among them, there were 14 (46.7%) requests for help and 10

(33.3%) deviations in the course of the task. The average time to perform the task was two minutes and 16 seconds. The minimum time was twenty-seven seconds and the maximum time was five minutes and forty seconds.

The dynamic lesson plan creation feature has proven to be suitable for the practice of collaborative lesson planning, which can create unstructured plans, that is, it can be created based on the teachers' own desires and needs. It can be seen that the environment was recognized as a place for exchanging experiences and co-creation of resources. In addition, the advantage that the dynamic plan could be shared with students was highlighted. In other words, it would have the function of a lesson plan and a resource. Such a practice could minimize the time spent between having to create the traditional lesson plan - which is mostly useful for the school's legal compliance purposes - and reporting to the state information system. The creation interface was received as a novelty by the teachers. Therefore, interface elements that explain certain functionalities were desirable. The results may relate to feeling helped and supported by co-workers, and increased satisfaction with professional development opportunities.

Figure 16 - Dynamic lesson plan creation screen (high-fidelity prototype)



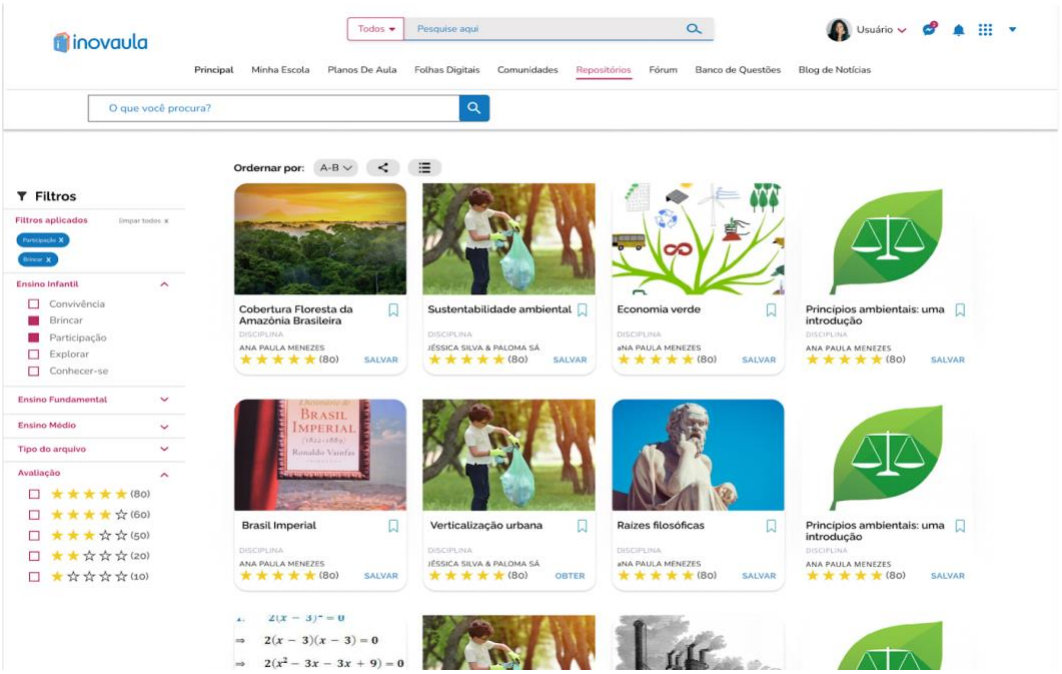
Source: The author (2022).

For activity (iv) in repositories, find and open an Environmental Sustainability Education resource (see Figure 17), all 30 (100%) participants completed the activity. Among them, there was 1 (3.3%) request for help and 3 (10%) deviations in the course of the task. The average time to perform the task was thirty-five seconds. The minimum time was five seconds and the maximum time was four minutes and twenty-six seconds.

Offering resources from different digital educational repositories allows teachers to carry out their collaborative lesson planning activities in groupware. The repository feature was perceived as useful for use in contingency situations. The use of offline resources was a desired feature. This desire must be associated with creative improvisations, since it is often necessary to make adaptations to the classroom.

Collaboration through open resources, enabling the reuse of educational resources, can be a practice to connect with the lack of time for lesson preparation. The availability of resources from external sources in groupware allows teachers scenarios for lesson preparation according to their circumstances. A participant stressed the importance of being able to exchange experiences, know-how planning is carried out in other places, and also being able to present how the user of the groupware performs.

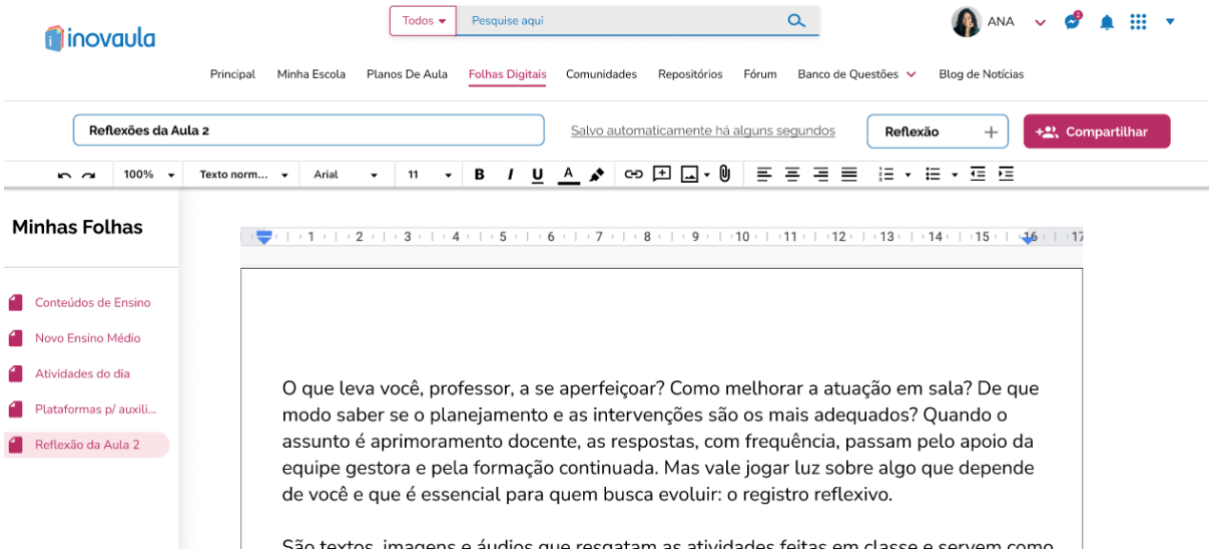
Figure 17 - Resource repositories screen (high-fidelity prototype)



Source: The authors (2022).

Finally, for activity (v) Create a digital sheet, fill it out, and share it with another teacher (see Figure 18), all 28 (93.3%) participants completed the activity. Among them, there were 3 (10%) requests for help and 4 (13.3%) deviations in the course of the task. The average time to perform the task was 1 minute and ten seconds. The minimum time was fourteen seconds and the maximum time was three minutes and twenty-two seconds.

Figure 18 - Digital sheet screen - reflections from class 2 (high-fidelity prototype)



Source: The authors (2022).

The manipulation of the digital sheet allowed the teachers to relate the practice of recording physical artifacts to the possibility of doing it via groupware. Teachers associated the feature with date management activities, activity control, and personal organization. This may have occurred because metaphors were adopted from artifacts used in the daily life of teachers, such as notebooks, calendars (located on the homepage), and file organizers.

4.3.2 Statistical Analysis

4.3.2.1 Levels of Well-being Aroused in the Teacher: correlations when performing a collaborative lesson planning activity in groupware

In this section, the results of the well-being questionnaire are presented from the manipulation of the class planning groupware prototype. The results present the domains of affect, community, and work. Besides the reaction in teachers, there is the

correlation of the variables for each domain and the association of the collaborative lesson planning activity in groupware.

4.3.2.1.1 Awakened Well-being Levels and Their Correlations

The analysis considers the affect domain of well-being in the following: happy (FELI), calm (CALM), sadness (TRIS), stress (ESTR) and frustration (FRUS). In hypothesis H2, the analysis considers the indicators for community domain, which are the following: PECO, NPEC, AHAV, AJUD, CONF and CUID. For hypothesis H3, the analysis considers the indicators for the work domain: SATR, DSAT, VIPI, VIDE, SRBE, AJCO, PROD, EQTE, DEQT and DEPR.

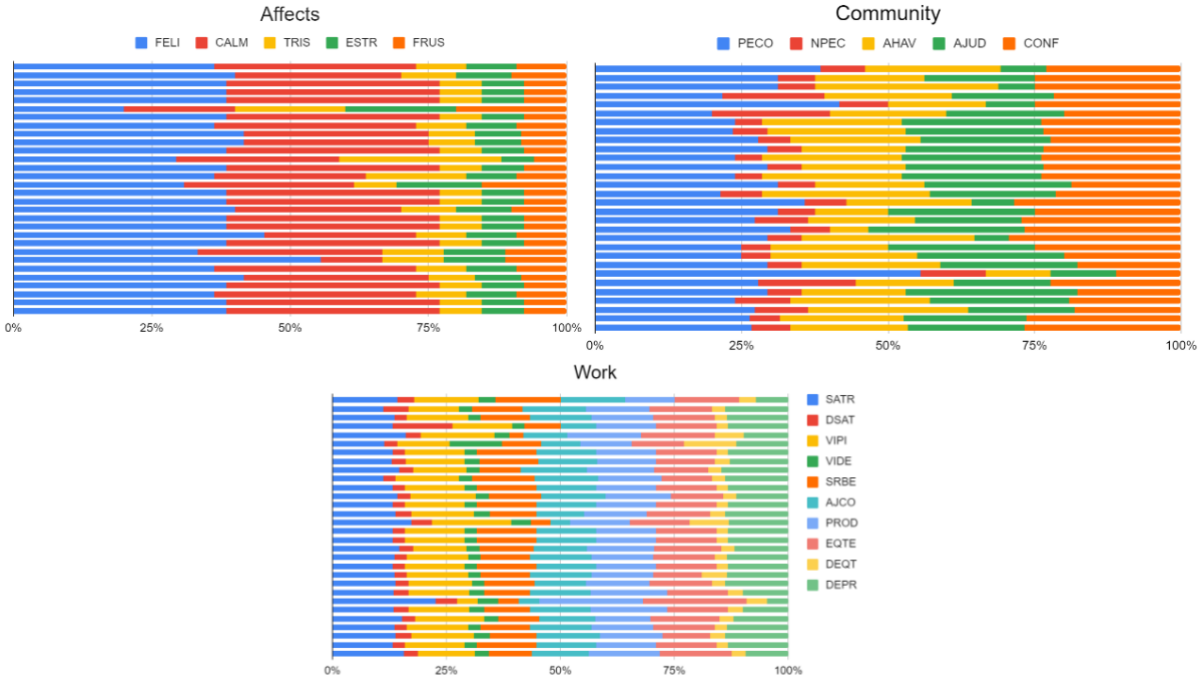
Figure 19 illustrates how affects, perception of community, and work are aroused for well-being when manipulating the prototype collaborative lesson planning system. The 'X' axis shows the values of the teachers' perceptions. The 'Y' axis corresponds to the response of each participant.

It can be seen that happiness (FELI) was the most reported affect for the teachers, with a mean equal to 4.60. The second highest perception was calmness (CALM), with a mean equal to 4.20. Therefore, the affects of happiness and calmness represent the affections most aroused in teachers when performing collaborative lesson planning activities in a groupware.

It can be seen that the variable of sense of belonging to a community (PECO) was the most highly perceived by teachers, with a mean equal to 5.00. The second and third variables that showed highest response were feelings of help from friends or relatives (AJUD) and feelings of trust in people in the community (CONF), both with mean scores of 4.00. The feeling that the participant would be rejected by a community was (NPEC) ($\underline{X} = 1$), with a mean of 1.00. Therefore, the feeling of belonging to a community represents the most perceived indicator for teachers when performing collaborative lesson planning in a groupware prototype.

It is noticeable that the increase in work productivity (PROD) was the teachers' highest perception, with a mean equal to 4.70. The second highest perception was that of increased job satisfaction (SATR), with a mean equal to 4.67. Therefore, perceptions of increased productivity and job satisfaction represent the work indicators most aroused in teachers when performing collaborative lesson planning activities in groupware.

Figure 19 - Perceived Affects of Well-Being



Source: The author (2022).

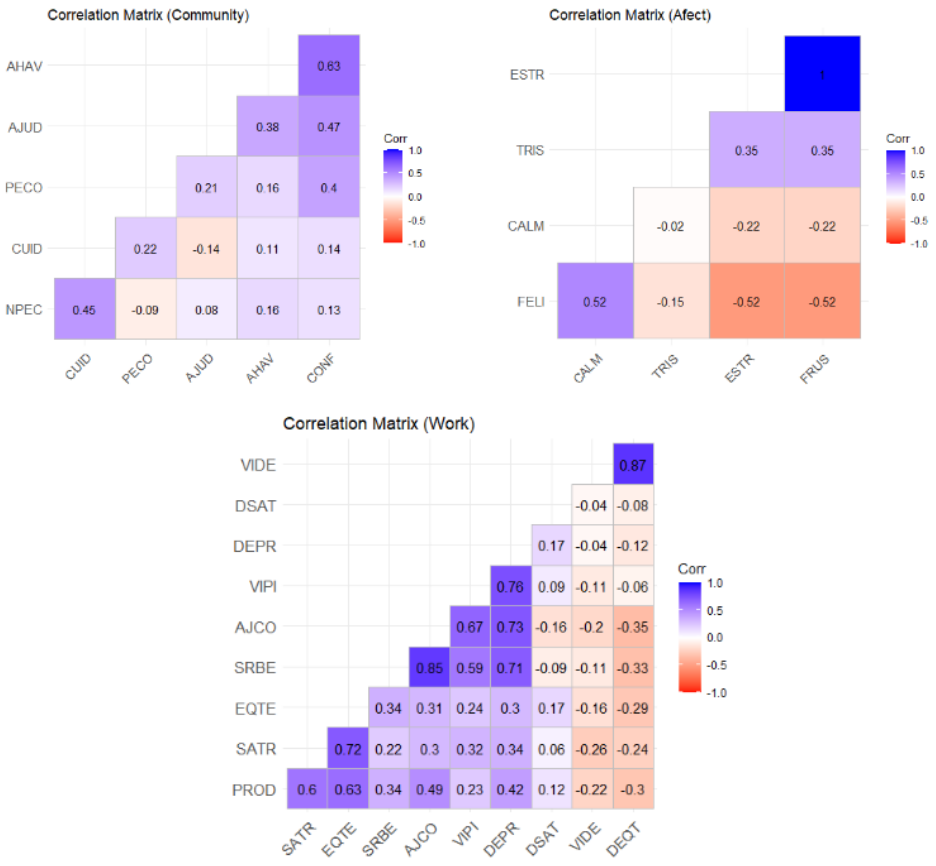
Figure 20 presents the correlation matrix of the variables for affect, community, and work domains of well-being. We can observe positive correlations between the variables AHAV and CONF. This allows us to understand that when planning in groupware more teachers get involved in voluntary activities (AHAV), proportionally increasing the feeling of confidence (CONF). A similar correlation can be seen between AJUD and CONF, which for teachers can be established as a mutual relationship: the more that trust is established (CONF), the more help is created (AJUD). Negative correlations can be seen between CUID and AJUD, which leads us to emphasize that when teachers are more careful in dealing with people (CUID) they offer less help (AJUD). The inverse is also valid.

It can be seen how positive and negative correlations can occur. For example, there is a positive correlation between happy (FELI) and calm (CALM) affect, i.e., teachers who planned in groupware felt happy and calm. There is a positive correlation between sad affect (TRIS) and stressed affect (STR) and frustrated affect (FRUS). Inversely, teachers did not have negative feelings aroused when carrying out lesson planning activities.

There is a strong correlation between feeling that their supervisors respect and care about their well-being, (SRBE), and feeling that they get help and support from

co-workers (AJCO) This allows us to understand that when planning in groupware, the more teachers perceive that their supervisors care about their well-being and respect them, the feeling of support from co-workers increases It is noticeable that there is a strong correlation between the SRBE and AJCO variables and the VIPE variable, showing a feeling of interest in professional life for teachers.

Figure 20 - Correlation matrix of Community, Affects, and Work



Source: The author (2022).

There is a strong correlation between feeling that work life is uninteresting (VIDE) and decreasing satisfaction with the balance between time spent at work and time spent in other dimensions of life (DEQT). This shows us that when planning in groupware, the more teachers balance between time spent at work and time spent on other aspects of life, the greater the perception that work life is uninteresting.

There is a strong correlation between feeling that professional life is interesting (VIPI) and increased satisfaction with professional development and promotion opportunities in the current main job (DEPR). This allows us to understand that when planning in groupware teachers perceive that the greater the feeling that professional

life is interesting, there is a proportional increase in satisfaction with professional development opportunities and promotion in the current main job.

There is a strong correlation between the increase in job satisfaction (SATR) and the increase in satisfaction with the balance between time spent at work and time spent on other aspects of life (EQTE); which allows us to understand that when planning in groupware teachers perceive that the greater the satisfaction with work, there is a proportional increase in the satisfaction with the balance between the time spent at work and the time spent on other aspects of life.

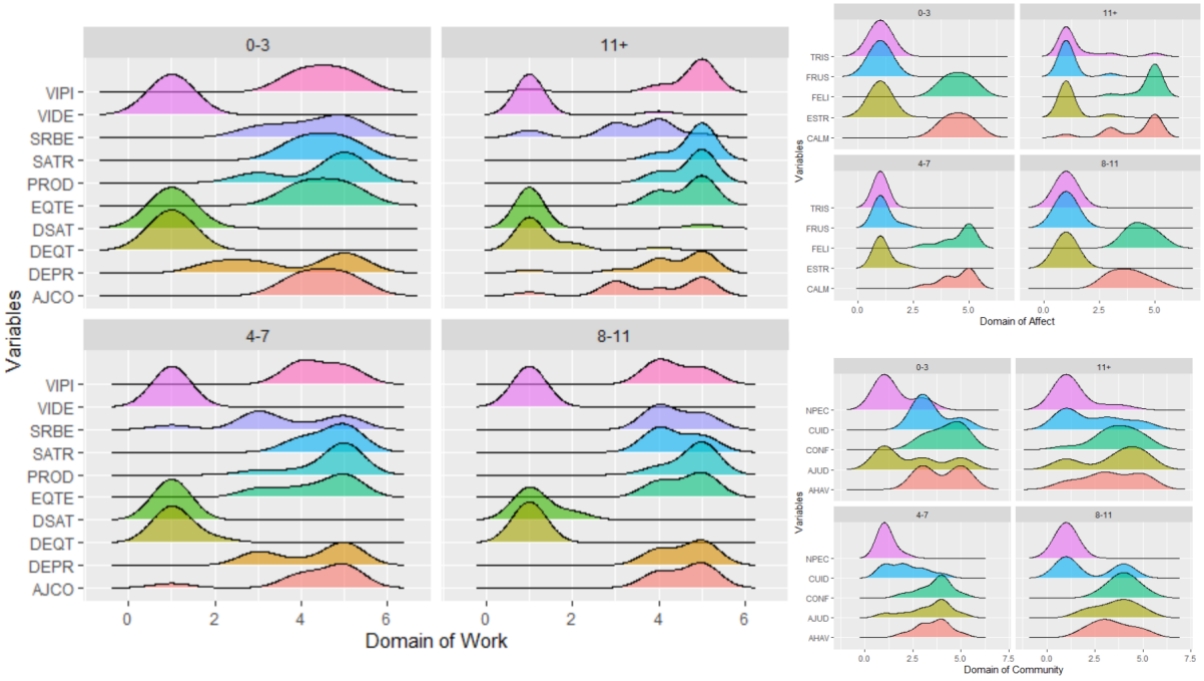
When asked about their teaching experience, the teachers in the sample have zero to more than eleven years of experience, distributed as: between zero and three years (13.3%), four and seven years (30%), between eight and eleven years (16.7%), and more than eleven years (40%).

In figure 21, all intervals of teaching time can be seen (TEDO). The distributions of density cursors of negative affects (TRIS, FRUS and ESTR) have a value close to 1. Therefore, when performing collaborative lesson planning activities, no negative affect is perceived in any range of teaching time. The positive affections (FELI and CALM) have dispersed density between values 3 and 5 for all ranges, with the range of teachers with more than eleven years of experience standing out, where it is possible to observe that there is a higher concentration in the value close to five.

The distributions of density in the work domain (VIDE, DSAT and DEQT) have a proportion close to the value 1. Therefore, when doing the collaborative lesson planning activities, there is no perceived decrease in satisfaction, no feeling that work life is uninteresting, and no decrease in satisfaction with the balance between time spent at work and time spent on other aspects of life for any range of time spent teaching. The indicators SATR, VIPI, SRBE, AJCO, PROD, EQTE and DEPR have dispersed density between values 3 and 5 for all ranges, highlighting the range of teachers with more than eleven years of experience, where it is possible to observe that there is a higher concentration in the value close to five.

In the distributions of the density cursors of the NPEC indicator, the work domain has a proportion close to the value 1. Therefore, when carrying out collaborative lesson planning activities, it is not rejected by a community. The indicators CONF, AJUD and AHAV have dispersed density between values 3 and 5 for all ranges.

Figure 21 - Density curves between affects and teaching time



Source: The author (2022).

In figure 22, it can be seen that density distributions were noticed among teachers who plan daily (10%) and weekly (66.7%) and bimonthly (16.7%). The teachers who plan semiannually and annually correspond to three point three percent (3.3%) each.

The distributions of densities of affections (TRIS, FRUS and ESTR), of community (NPEC and CUID) daily and bimonthly, and of work VIDE, EQTE and DSAT have a proportion close to the value 1 (Figure 22).

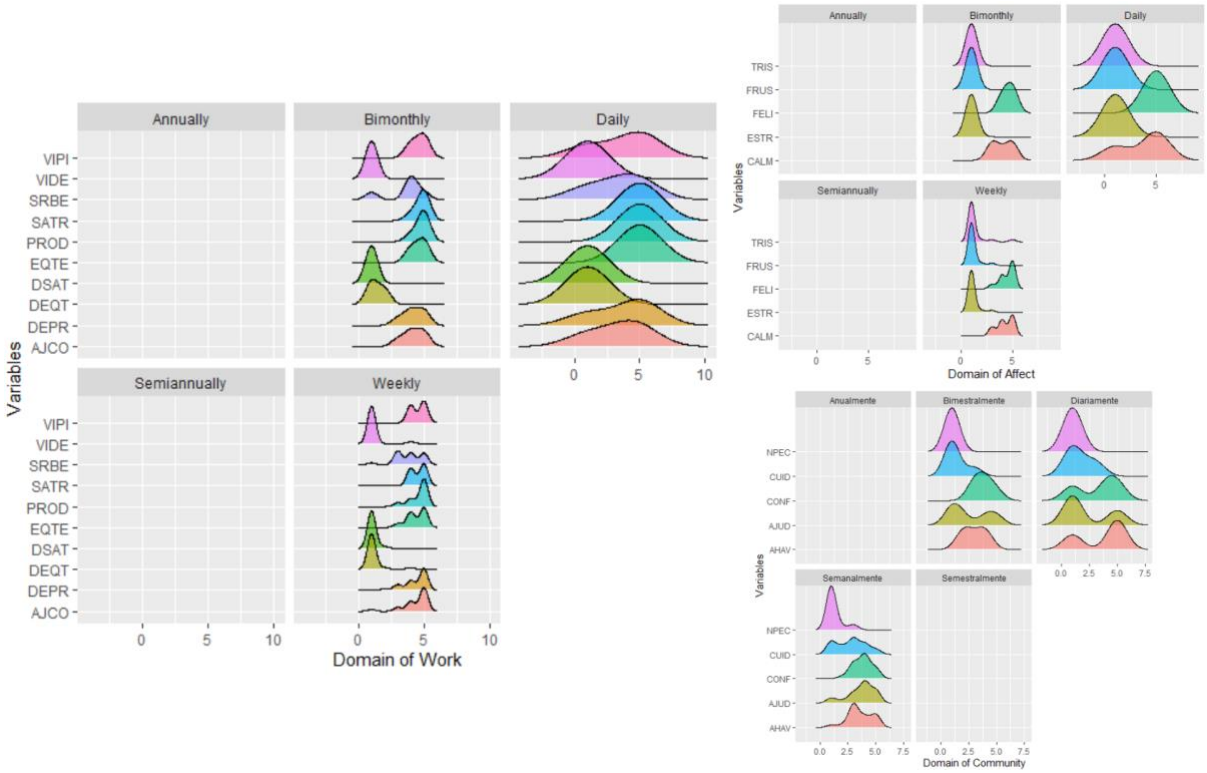
In the affect domain, no negative affect is perceived in teachers who perform the planning activities daily, weekly, and bimonthly. For the group that plans lessons daily, normal curves can be observed, except for the feeling of calm (CALM), where the curve is dispersed. The positive affections (FELI and CALM) have densities between the values of 3 and 5 for all ranges, highlighting that there is no distribution for teachers who plan semiannually and annually, which may indicate that among the observed sample, teachers neither agree nor disagree, agree and totally agree that performing the collaborative lesson planning activities in groupware could have positive feelings.

In the community domain, the indicators CONF, AJUD, and AHAV have densities between values 3 and 5 for the whole group that conducts weekly lesson

planning, which may indicate that groupware can promote the perception of trust, helpfulness, and volunteer work. The teachers did not completely agree that using groupware made them feel rejected by a community.

In the community domain, the other indicators have densities between values 3 and 5 for all ranges, except for teachers who plan semi-annually and annually.

Figure 22 - Smoothed density curves between affect and planning frequency



Source: The author (2022).

4.3.2.2 Principal Component Analysis

Based on the results of the principal component analysis technique, the first two principal components (PCs) explained 77.14% of the dispersion of the original data, regarding the positive and negative affects perceived by teachers when performing collaborative lesson planning activity in a groupware. Among them, PC1 is responsible for 54.16% and PC2 is responsible for 22.98% of the original data dispersion (see Figure 23).

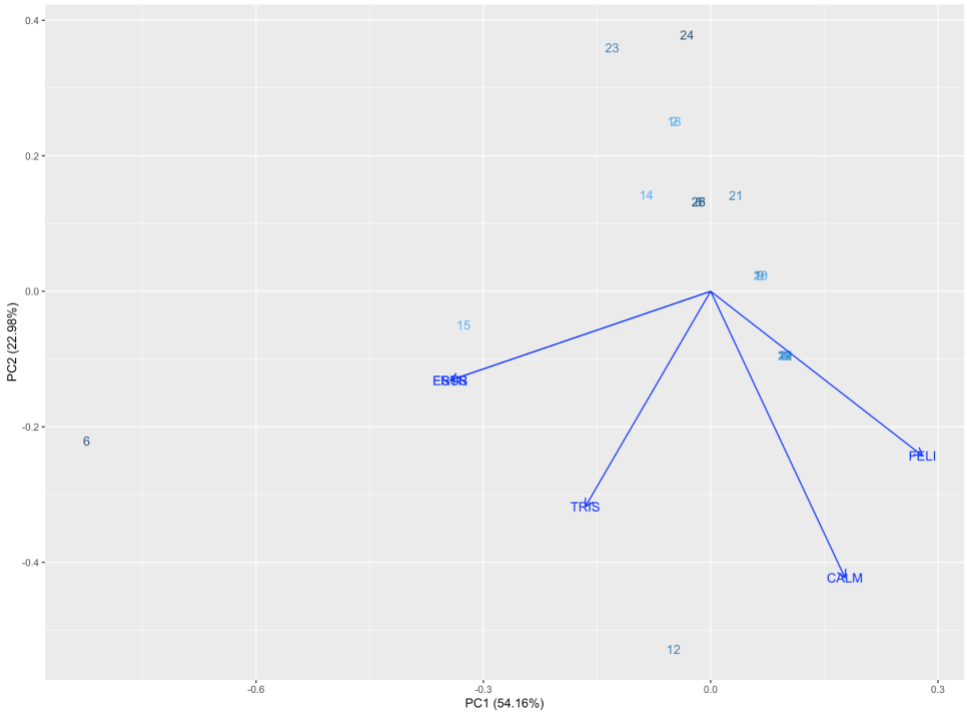
The research participants are dispersed across the components (PC1 and PC2). PC1 can be described as being sensitive to negative feelings (TRIS, ESTR and

FRUS) and to positive feelings (FELI, CALM). PC2, on the other hand, can be described as being sensitive to negative feelings.

In the same way, the components were related to the community. We can see that the technique (PCA) returned an explanation for 61.4% of the data dispersion. In PC1 it represents 37.32% and PC2 represents 23.72% (see Figure 24). Scattered across the components, all community-related variables are arranged in the negative quadrants for PC1; the same can be observed for the variables (NPEC and CUID) for PC2. The variables (AJUD, CONF, AHAV and PECO), on the other hand, are arranged in the positive quadrant for PC2.

For the labor-related components, the (PCA) technique returned results for 60.25% (PC1 = 41.73% and PC2 = 18.52%) (see Figure 25). Scattered across the components, the variables (VIPI, DEPR, SRBE and AJCO) contribute positively to both PC1 and PC2. The variables (DEQT and VIDE) contribute positively to PC2, but contribute negatively to PC1. Similar but opposite behavior can be seen for the variables (DSAT, PROD, EQTE, and SATR) that contribute positively to PC1, but negatively to PC2.

Figure 23 - Affects - scores and factor loadings of the affects for components PC1 and PC2

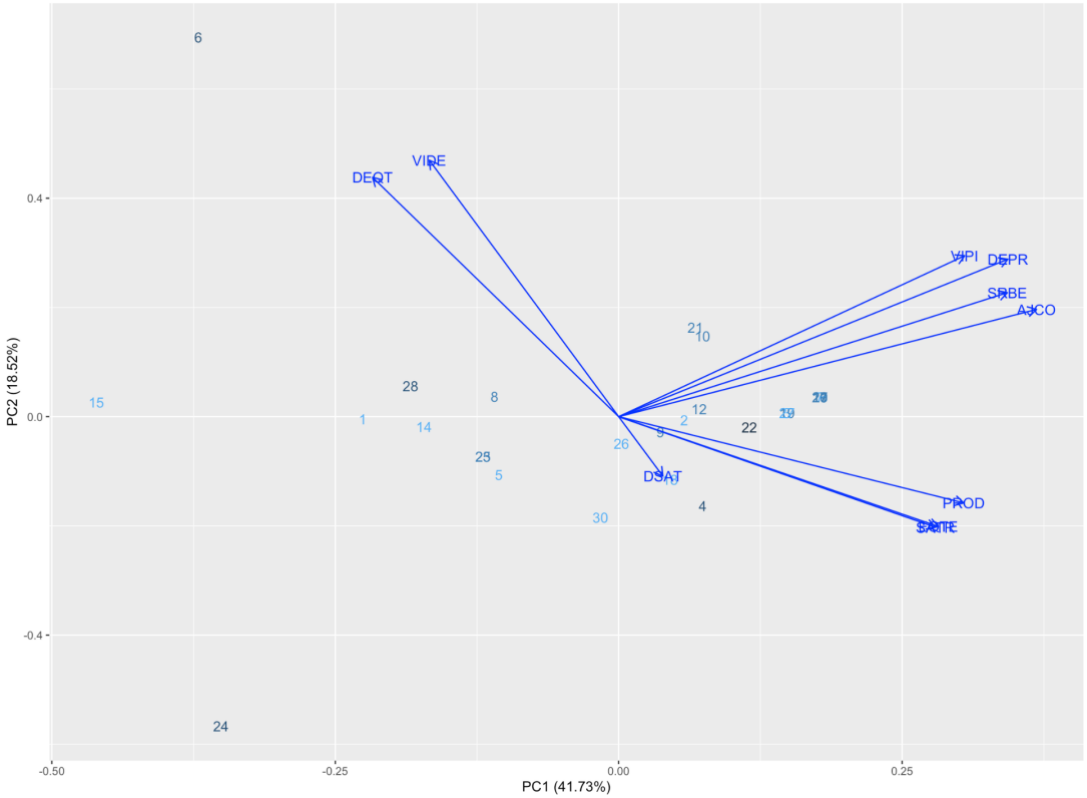


Source: The author (2022).

Figure 24 - Community - scores and factor loadings for components PC1 and PC2

Source: The author (2022).

Figure 25 - Work - scores and factor loadings for components PC1 and PC2



Source: The author (2022).

It can be understood that the affects of happiness and calm are the ones with positive modules among the perceptions of all affects. However, the higher the value of the modulus, the greater the influence on the component. We can see that component (PC1) is most influenced by the variables TRIS, ESTR and FRUS. Therefore, when teachers perform a collaborative lesson planning activity in groupware, negative affects have the most influence when it comes to well-being in collaborative lesson planning.

The results of the community-related PCs allow us to interpret that, for example, the greater the feeling of rejection by the community (NPEC) and of feeling that you need to be careful when dealing with people (CUID), the lower the value of this component when related to the other variables.

Regarding work-related PCs, they allow us to compare the influence of the variables perceived as satisfaction with work (SATR), decreased satisfaction with work (DSAT), increased productivity at work (PROD), and increased satisfaction with the balance between time spent at work and time spent on other aspects of life (EQTE) with the other variables. The lower the PC1 values, the higher the perceptions of the other variables, and vice-versa.

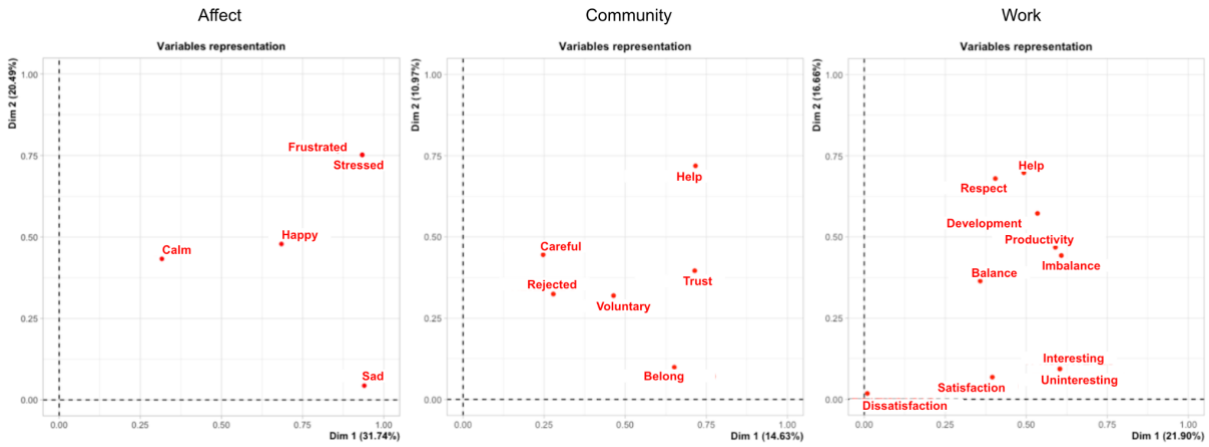
4.3.2.2.1 Correspondence Analysis

Based on the results of the correspondence analysis (CA) technique, the two dimensions (Dim) of CPs explain 52.23% of the original variability in the data, concerning the positive and negatives affect aroused in teachers when performing collaborative lesson planning activities in a groupware. Here, Dim 1 accounted for 31.74% and Dim 2 accounted for 20.49% of the variations in the data. For the community domain, the first five dimensions of PCs explain 52.898% and for the work domain, the first three dimensions of PCs explain 50.602% of the original variability of the data

All events are located in the first quadrant, as all values are positive values (See Figure 26). The negative affects of stress and frustration have high proximity, considered mutually equivalent, with values of 0.933 in Dim 1 and 0.751 in Dim 2, respectively. The positive affects that arouse calm and happiness are located independently. Sadness shows itself in Dim 1 and closes to zero in Dim 2, i.e., teachers consider that lesson planning supported by groupware does not arouse the feeling of

sadness. The three negative affects display a result close to 1 in the first dimension. There is also the feeling of help (AJUD) from the community domain, with values of 0.716 in Dim and Dim 2. The perception that makes one feel that professional life is interesting (VIPI) and makes one feel that professional life is uninteresting (VIDE) display high proximity, considered mutually equivalent, with values of 0.603 in Dim 1 and 0.09 in Dim 2, respectively. The increase in productivity at work (PROD) is similar to the decrease in satisfaction with the balance between time spent at work and time spent in other aspects of life (DEQT). Decreased job satisfaction (DSAT) has values close to zero in the first two dimensions.

Figure 26 - Contributions of the variables to the formation of the dimensions



Source: The author (2022).

4.3.2.2.2 Hierarchical and Non-hierarchical Grouping

A hierarchical clustering was created using Euclidean distance and the Average clustering method for the variables related to similarity of affect, community, and work. For affects, there is the formation of 6 clusters (cluster 1 = 1, cluster 2 = 1, cluster 3 = 1, cluster 4 = 1, cluster 5 = 18 e cluster 6 = 8). For communities, there is the formation of 5 clusters (cluster 1 = 1, cluster 2 = 2, cluster 3 = 4, cluster 4 = 18 and cluster 5 = 5). Finally, for work the formation of 7 clusters is indicated (cluster 1 = 1, cluster 2 = 1, cluster 3 = 1, cluster 4 = 1, cluster 5 = 1, cluster 6 = 19 and, cluster 7 = 6). The results presented in the dendrogram regarding similarity allow us to observe the individuals in their receptive clusters according to the observed variables (see Figure 27).

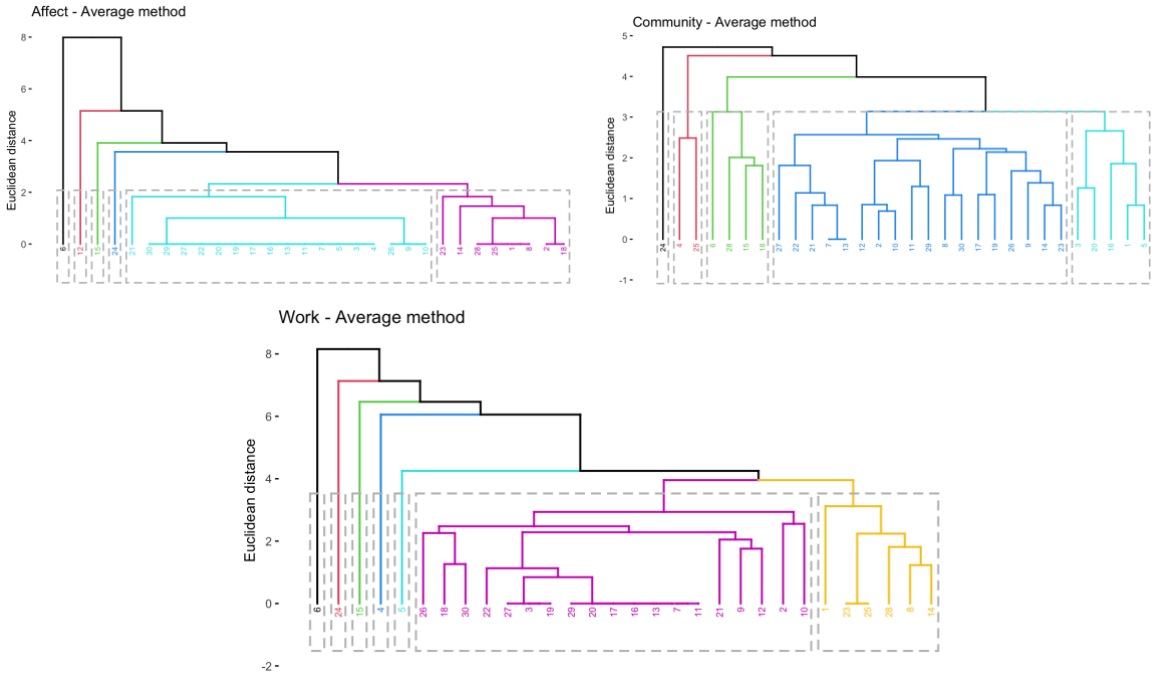
In the affect domain, the individuals in cluster 5, which has the largest number of individuals (=18), show similarities regarding positive feelings and negative feelings.

There are similarities between feeling happy and calm and between not feeling sad, stressed and frustrated. This must have occurred because, in feeling happy and calm, doing activities in groupware can help them in their collaborative lesson planning activities. That is, it would meet their needs and not promote negative feelings. Cluster 6 is formed by participants who show similarity between agreeing to feel happy and agreeing, and neither agreeing nor disagreeing, about feeling calm.

In the community domain, individuals in cluster 4, which has a greater number of individuals (=18), present similarities in relation to the perception of feeling that they belong to a community (PECO), disagreeing that they felt rejected by a community (NPEC) and feeling that if were in trouble, they would have friends or relatives they could count on to help whenever they needed them (AJUD). The 5 individuals in cluster 5, as well as in cluster 4, show similarities of the same variables, but with all responses completely agreeing for PECO and AJUD and completely disagreeing for NPEC. The 4 individuals in cluster 3 show similarities only in the perception of feeling that they belong to a community (PECO).

In the work domain, individuals in cluster 6, which has the highest number of individuals (=19), show similarities in terms of the perception of increased job satisfaction (SATR), feeling that professional life is interesting (VIPI), getting help and support from co-workers (AJCO), increased productivity at work (PROD) and increased satisfaction with balancing time spent at work and time spent in other aspects of life (EQTE); The 6 individuals in cluster 7 show similarities for the variables SATR and VIPI in agreeing (Likert = 4). There is a relationship between completely disagreeing that it decreases job satisfaction (DSAT), that it makes one feel that professional life is uninteresting (VIDE) and that satisfaction decreases with the balance between time spent at work and time spent on other aspects of life (DEQT). This must have occurred because, when carrying out collaborative lesson planning activities in a groupware, they realized that there could be an increase in job satisfaction, an interesting professional life, help from colleagues and an increase in productivity. That is, the denial of these perceptions would not be perceived.

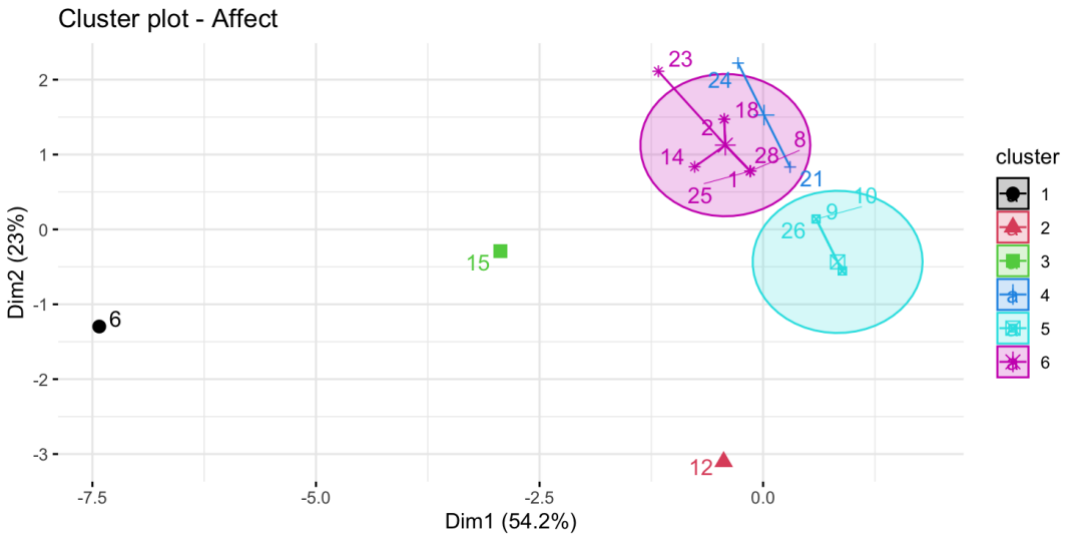
Figure 27 - Dendrogram of the affects of participants by the Average method



Source: The author (2022).

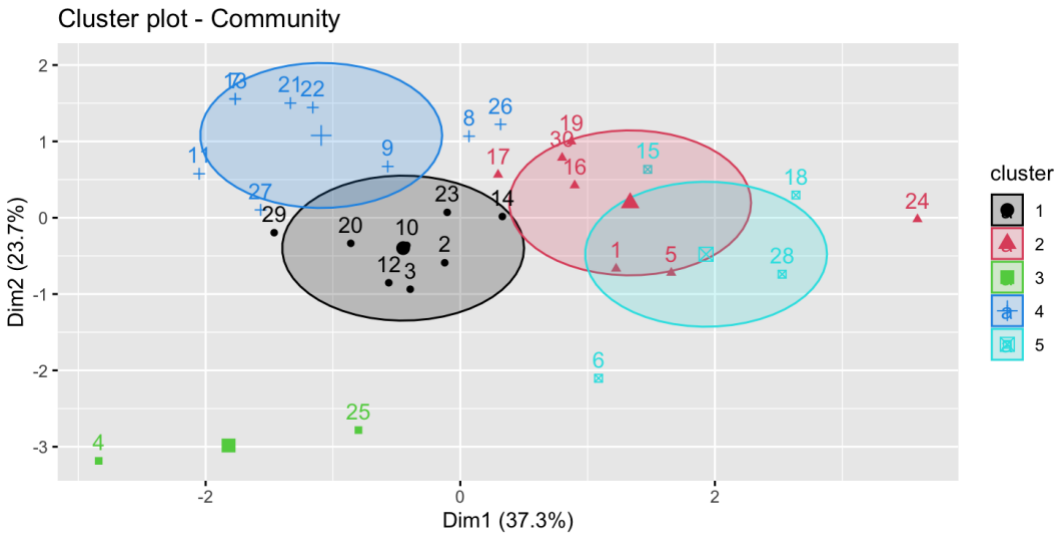
In Figures 28, 29 and 30, the principal components technique was used (k-means). The method uses the first two dimensions to generate a two-dimensional graph. As the resulting dimensions are linear combinations of the variables of affect, community and work, the clusters formed in each graph make it possible to identify groups of individuals with intersecting similarities. The method's algorithm allows the visualization of 6 clusters for affect, 5 clusters for the community domain, and 7 clusters for the work domain.

Figure 28 - Clusters generated by the variables of affect



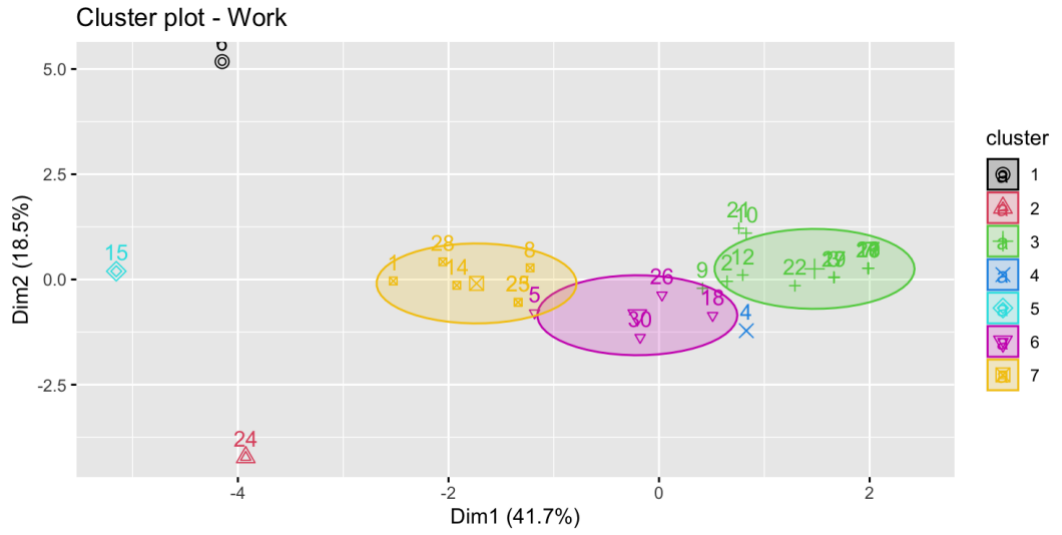
Source: The author (2022).

Figure 29 - Clusters generated by the variables of community



Source: The author (2022).

Figure 30 - Clusters generated by the variables of work



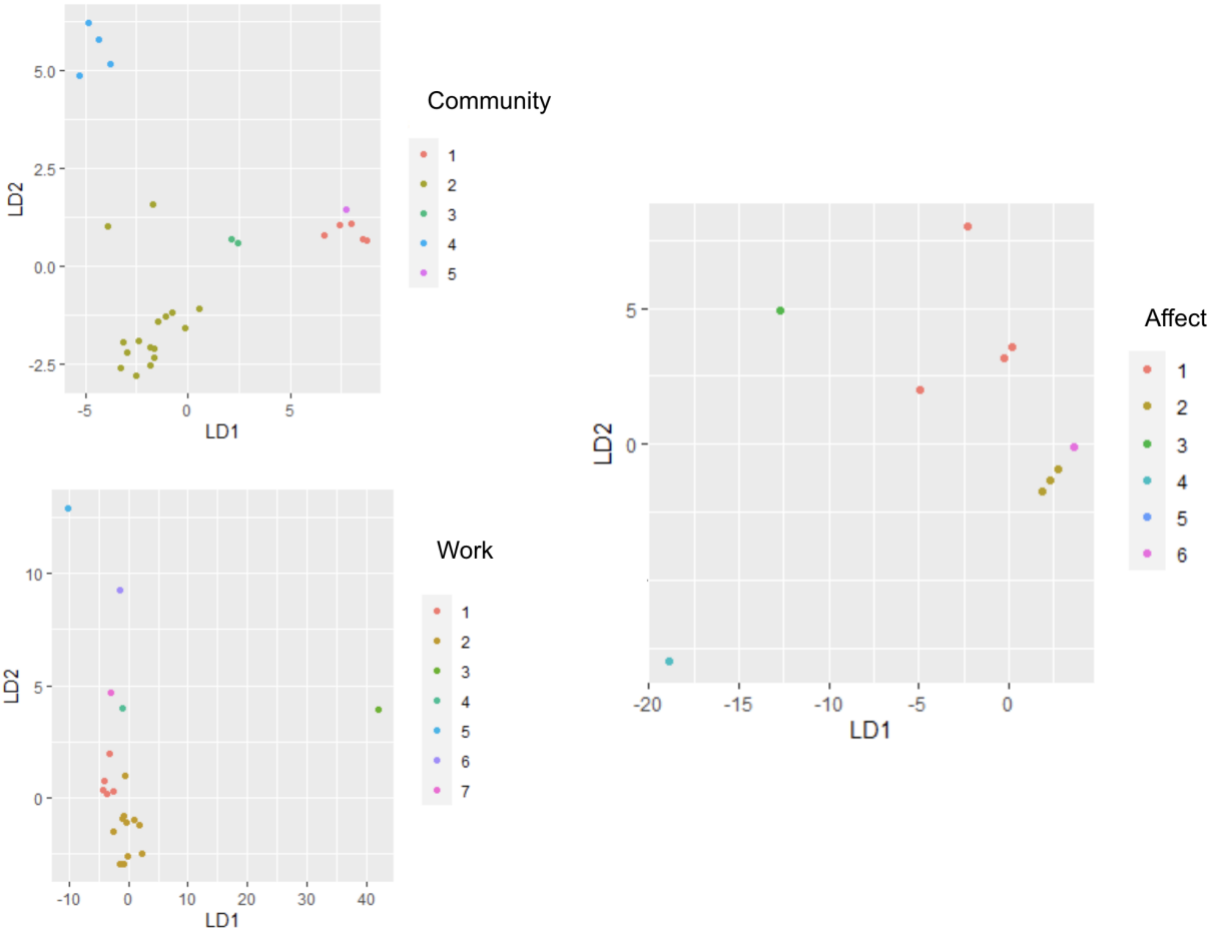
Source: The author (2022).

In affects, the individuals in clusters 5 and 6 differ from those in clusters 1, 2, 3 and 4. This may have occurred because the variability of perceptions of affect occurred as follows: P6 felt indifferent to all affects, P12 felt happy, calm and sad proportionally, and P15 disagrees that he felt stressed and frustrated. In the domain Individuals in clusters 3, 6 and 7, there is a contrast with other clusters.

4.3.2.2.3 Discriminant Analysis and ANOVA

In figure 31, the discriminant function analysis was used to observe discrimination assigned to the groups for affects, community, and work. The plotted points are the elements rewritten as a function of their linear combinations. A rate of 96.6%, 100% and 96% was obtained for the accuracy of data discrimination, respectively. When we analyze the positioning of the groups, it is confirmed that the proposed group formation has high accuracy rates.

Figure 31 - Discriminant analysis of affect, community, and work



Source: The author (2022).

When analyzing the group formations, we observed that the groups were well-defined in all three domains. In community, group 1 and group 5 show closeness to each other. In affect, there is a proximity between groups 2 and 6. Finally, there is the proximity between groups 1 and 2.

A Wilcoxon post-test was carried out to test whether the medians of the samples are equal in cases where the normality assumption is not satisfied or when it is not

possible to check this assumption. Different letters indicate that the groups differ from each other at a level of 5% by the Wilcoxon post-test, given that the Kruskal-Wallis test was significant. The Kruskal-Wallis test was significant (see Tables 8, 9 and 10).

Table 8 - Wilcoxon post-test - Affects

Cluster	FELI	TRIS	CALM	ESTR	FRUS
1	3,88[a]	1,12[ab]	3,50[a]	1,00[a]	1,00[a]
2	5,00[b]	1,00[a]	4,72[b]	1,00[a]	1,00[a]
3	3,00[a]	3,00[b]	3,00[ab]	3,00[b]	3,00[b]
4	5,00[ab]	5,00[b]	5,00[ab]	1,00[ab]	1,00[ab]
5	4,00[a]	1,00[ab]	4,00[ab]	2,00[b]	2,00[b]
6	5,00[ab]	1,00[ab]	1,00[ab]	1,00[ab]	1,00[ab]

Source: The author (2022).

Table 9 - Wilcoxon post-test - Community

Cluster	PECO	NPEC	AHAV	AJUD	CONF	CUID
1	3,00[a]	1,50[ab]	3,00	2,50[a]	2,75	2,00
2	4,89[a]	1,11[a]	4,44	4,78[b]	4,33	1,44
3	5,00[ab]	1,00[b]	3,75	3,12[abc]	4,00	3,75
4	5,00[b]	3,50[ab]	4,00	3,50[c]	4,50	5,00
5	4,86[ab]	1,00[ab]	2,14	2,14[abc]	3,29	1,71

Source: The author (2022).

Table 10 - Wilcoxon post-test - Work

Cluster	SATR	DSAT	VIPI	VIDE	SRBE	AJCO	PROD	EQTE	DEQT	DEPR
1	5,00	1,00[a]	1,00[a]	1,00[a]	1,00[a]	1,00[a]	5,00[a]	5,00	1,00[a]	1,00[a]
2	4,88	1,06[a]	4,88[b]	1,00[a]	4,44[b]	4,94[b]	5,00[b]	4,75	1,06[a]	4,94[b]
3	4,00	1,00[b]	4,00[ab]	1,00[ab]	3,33[ab]	3,83[a]	4,17[ab]	3,83	1,00[ab]	3,33[ab]
4	4,00	1,00[ab]	4,00[ab]	4,00[ab]	3,00[ab]	3,00[a]	4,00[ab]	4,00	4,00[b]	4,00[a]
5	5,00	5,00[ab]	5,00[ab]	1,00[b]	3,00[ab]	3,00[a]	5,00[a]	5,00	1,00[b]	5,00[a]
6	4,00	1,00[ab]	4,00[ab]	1,00[ab]	1,00[ab]	1,00[a]	3,00[a]	3,00	2,00[b]	3,00[a]
7	5,00	1,00[ab]	4,50[ab]	1,00[ab]	2,75[ab]	3,75[a]	4,75[ab]	5,00	1,25[ab]	3,50[a]

Source: The author (2022).

4.4 CONCLUSIONS

To conclude, this study shows that conducting collaborative lesson planning activities on a lesson planning groupware prototype designed from participatory design with basic education (K-12) teachers is a perceived approach, as it enabled the design of meaningful artificial artifacts for teachers. The teachers felt happy and calm when performing activities. However, negative affects have a greater influence when it

comes to well-being in collaborative lesson planning. In other words, negative feelings are relevant facts for using a groupware.

We believe that these results are related to the work of teachers, as they work under visible stressful conditions (BAKKENES et al., 1999; VANGRIEKEN et al., 2015), and isolation in lesson planning activities (PATTON; PARKER, 2017; ROSSITTO, 2018). When doing collaborative lesson planning activities on groupware they realized that they felt they belonged to a community and could be helped by it, and that they did not feel rejected by the community of teachers.

This study has some limitations, related to the number of participants. The sample for future work could be larger. A future study can be conducted in a real work context. The study, in real working conditions and followed for a longer period, can help us to better understand how each feature (design recommendation) of a groupware can contribute to the well-being of teachers. Therefore, it is suggested that further studies examine the affects of perceptions of improvement in collaborative lesson planning practice for groupware.

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APPENDIX A – WELL-BEING QUESTIONNAIRE - GROUPWARE

Questionário de testes de bem-estar em protótipo de sistema colaborativo mediador de atividades de planejamento de aula

Olá! Meu nome é Leandro Marques Queiros. Sou doutorando em Ciência da Computação no Centro de Informática (CIn) da Universidade Federal de Pernambuco (UFPE), sob orientação do Prof. Dr. Alex Sandro Gomes (CIn-UFPE) e coorientação da Profª. Drª. Rosane Maria Alencar da Silva. Buscamos investigar as recomendações de design no desenvolvimento de sistema colaborativo mediador de atividades de planejamento de aula realizada por professor(a) do Ensino Básico. Sua participação é de suma importância para a conclusão da minha pesquisa de doutorado. Os resultados desta pesquisa serão consolidados antes de serem divulgados, mantendo a confidencialidade dos dados individuais.

Você está sendo convidado(a) para participar, como voluntário(a), da atividade de teste de protótipo de sistema colaborativo como professor(a) do Ensino Básico.

O formulário contém perguntas diversas, e seu tempo estimado de resposta é de 15 minutos.

FASE 1 - Termo de Consentimento Livre e Esclarecido

Declaro ter ciência e estar esclarecido(a) sobre os seguintes pontos:

1. A pesquisa tem por objetivo investigar as recomendações de design no desenvolvimento de sistema colaborativo mediador de atividades de planejamento de aula realizada por professor(a) do Ensino Básico.

2. A minha participação nesta pesquisa consistirá em participar como professor(a) na Educação Básica das atividades de teste de sistema colaborativo.

3. Ao participar deste trabalho, estarei contribuindo para o levantamento de dados, avaliação e/ou debate para a criação, aprofundamento e/ou melhorias para

recomendações de design para o desenvolvimento de sistema colaborativo mediador de atividades de planejamento de aula realizada por professor(a) do Ensino Básico.

4. A minha participação nesta etapa de teste de sistema colaborativo deverá ter a duração de, aproximadamente, 15 minutos, podendo ter seu áudio e tela gravada, a critério do pesquisador. No caso de a participação ser gravada, os áudios, após a transcrição ou confecção de relatório, serão devidamente armazenados.

5. Estou ciente de que não há nenhum valor econômico, a receber ou a pagar, por minha participação.

6. Não terei nenhuma despesa ao participar da pesquisa e poderei deixar de participar ou retirar meu consentimento a qualquer tempo, sem precisar justificar, e não sofrerei qualquer prejuízo.

7. Meu nome será mantido em sigilo, assegurando, assim, a privacidade e anonimato, sendo tratado, genericamente, como professor(a). Além disso, se eu desejar, terei livre acesso a todas as minhas informações e esclarecimentos adicionais sobre o estudo.

8. Estou ciente de que os dados coletados serão utilizados, única e exclusivamente, para fins acadêmicos, e que trechos das atividades poderão ser incluídos na tese do pesquisador, relatórios de pesquisa ou em quaisquer outras publicações posteriores, sem citar o nome do especialista ou da escola.

Declaro ter sido informado(a), que estou ciente e concordo em participar, como voluntário(a), da etapa da pesquisa acima descrita.*

Concordo

Discordo

* Resposta obrigatória

FASE 2 - Perfil demográfico

Qual é o seu nome?

Qual é o seu e-mail?

Qual é a sua faixa etária de idade?*

Entre 18 e 25 anos

Entre 26 e 30 anos

Entre 31 e 35 anos

Entre 36 e 40 anos

Entre 41 e 45 anos

Entre 46 e 50 anos

Entre 51 e 55 anos

Entre 56 e 60 anos

Acima de 60 anos

Qual é o seu sexo?*

Feminino

Masculino

Prefiro não responder

Qual é o seu tempo de docência?*

Entre 0 e 3 anos

Entre 4 e 7 anos

Entre 8 e 11 anos

Mais de 11 anos

Qual é o seu grau de instrução?*

Licenciatura

Bacharelado

Especialização

Mestrado

Doutorado

Pós-doutorado

Qual(is) nível(is) de ensino você ensina?*

Infantil

Fundamental

Médio

Superior

Técnico

Tecnólogo

Em qual município você trabalha?*

Lista dos municípios de Pernambuco, Brasil.

Em quantas escolas você trabalha?*

Em quantas turmas você ensina?*

Qual é a sua carga-horária de horas/aula semanal?*

Que disciplinas você ensina?*

Artes

Biologia

Ciências

Educação Física

Física

Geografia

História

Informática

Língua Estrangeira

Língua Portuguesa

Matemática

Química

Outro:

Quais são os principais canais de comunicação que você utiliza para se comunicar com colegas professores(as)?*

AVA (Ambientes Virtuais de Aprendizagem)

Contato pessoal

E-mail

Ligação telefônica

WhatsApp

Facebook

Telegram

Google Meet

Zoom

Skype

Outro:

Qual é o seu nível de proficiência no uso de Tecnologias da Informação e Comunicação nas suas atividades de planejamento de aula?*

1 - Nenhuma proficiência; 2 - Baixa proficiência; 3 - Indiferente; 4 - Alta proficiência; 5 - Proficiência avançada.

Você usa ou já usou algum software específico para preparar plano de aula?*

Sim

Não

Outro:

Você planeja suas aulas com qual frequência?*

Diariamente

Semanalmente

Mensalmente

Bimestralmente

Semestralmente

Anualmente

Nunca

Você já compartilhou seu(s) plano(s) de aula?*

Sim

Não

FASE 3 - Bem-estar

Entendendo bem-estar como o bem-estar físico, mental e social, contínuo e sustentável, de indivíduos, comunidades e populações, em que suas necessidades econômicas são atendidas em um ambiente ecológico e próspero, responda como o PROTÓTIPO testado faz você se sentir sobre os parâmetros abaixo.

Aumenta minha satisfação com a vida.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Diminui minha satisfação com a vida.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir feliz.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir triste.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir calmo.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir estressado.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir frustrado.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que as coisas que faço valem a pena.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que as coisas que faço não valem a pena.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que sou competente no que faço.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que não sou competente no que faço.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que pertenço a uma comunidade.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que sou rejeitado por uma comunidade.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumentaria o total aproximado de horas por mês em que estive envolvido em atividades voluntárias.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que se eu estivesse com problemas, teria amigos ou parentes com quem posso contar para me ajudar sempre que eu precisasse deles.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que posso confiar nas pessoas.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que preciso ter cuidado ao lidar com as pessoas.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumenta minhas chances de me envolver/participar em atividades artísticas ou culturais.*

Aumenta o meu grau de preocupação sobre perder meu emprego.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Diminui o meu grau de preocupação sobre perder meu emprego.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumenta o meu grau de satisfação com os esforços para preservar o meio ambiente.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumenta meu conhecimento sobre aquecimento global ou mudança climática.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que existe um espaço de liberdade de reunião, manifestação e discussão aberta.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir com energia e capaz de fazer as coisas.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir apático e incapaz de fazer as coisas.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumenta minhas oportunidades de aprender.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aprimora minhas habilidades de Tecnologias da Informação e Comunicação - TIC.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumenta minha satisfação com o trabalho.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Diminui minha satisfação com o trabalho.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que minha vida profissional é interessante.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que minha vida profissional é desinteressante.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que meus supervisores respeitam e se preocupam com meu bem-estar.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Me faz sentir que obtenho ajuda e apoio dos meus colegas de trabalho.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumenta minha produtividade no trabalho.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumenta minha satisfação com o equilíbrio entre o tempo gasto no trabalho e o tempo gasto em outros aspectos da vida.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Diminui minha satisfação com o equilíbrio entre o tempo gasto no trabalho e o tempo gasto em outros aspectos da vida.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Aumenta minha satisfação com as oportunidades de desenvolvimento profissional e promoção em meu trabalho principal atual.*

1- Discordo completamente, 2- Discordo completamente, 3- Não concordo e nem discordo, 4- Concordo, 5 - Concordo completamente.

Obrigado pela sua participação

Dúvidas ou sugestões podem ser enviadas para o e-mail: lmq@cin.ufpe.br