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Professional Development of In-Service Teachers: Use of Eye Tracking for Language Classes, Case Study

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Abstract: This article presents a study on in-service professional development of Lithuanian secondary school language teachers. The motivation is based on the understanding of language education as a highly interactive, complex process that requires a teacher's digital literacy skills combined with integrated instructional approaches. This requires the implementation of a set of professional development activities. As a research methodology, we use a mixed method approach based on collecting eye tracking data in the first phase and, then, focus on comparative teacher self-reflection using data analysis and qualitative interviews. Finally, based on the collected qualitative and quantitative data, educational experts develop and present recommendations on the scope and direction of professional development. As a result of this study, a comprehensive set of the eye tracking data from the experiment involving 93 participants in total and 23 recorded lessons is presented. This includes variables such as number of visits, time to first fixation, number of fixations, and fixation duration vertically and horizontally. The discussion presents the results of the qualitative part of the study, including comprehensive teachers' feedback. In conclusion, an integrated training program for in-service language teachers is presented, including an eye tracking experiment that provides data for extensive self-reflection and feedback.

Keywords: teachers' professional development; eye tracking; self-reflection; language education

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Citation: Dagienė, V.; Jasutė, E.; Dolgopolovas, V. Professional Development of In-Service Teachers: Use of Eye Tracking for Language Classes, Case Study. *Sustainability* **2021**, *13*, 12504. https://doi.org/10.3390/su132212504

Academic Editor: Cecilia Ruiz-Esteban

Received: 15 September 2021
Accepted: 9 November 2021
Published: 12 November 2021

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1. Introduction

1.1. Professional Development for Technology Supported Education

Education and professional development are important for in-service teachers both from professional and personal development perspectives. However, in everyday practice, educational programs are usually designed and developed in a country-centralized manner, are not obviously effective and acceptable for the school teacher, and particularly the language teacher herself (see, for example, [1]). The solution, in our view, would be a kind of decentralization aimed at professional development, based on encouraging cooperation between teachers, self-reflection, and a focus on natural educational settings such as a school class and supported educational environments. Such decentralization, however, ought to be supported at a higher level (represented by educational scientists and educational policy makers), which in any case requires corresponding resources to be allocated.

Language education, as opposed to education in general, requires certain specific issues to be considered for effective instruction to take place. One reason for this is the high level of interactivity inherent, for example, in learning a second language [2,3]. One of the solutions for resolving such interactivity in teaching and learning process is to deploy instruction which is based on a cognitive load model. In this regard, according to [4], such important "effects" of cognitive load-based instruction are, for example: split-attention, modality, transiency, redundancy, expertise reversal as well as element interactivity, and also working memory depletion should be mentioned. In order for these aspects to be

taken into account in everyday pedagogical practice, a language teacher must be practically involved in the complex process of integrated instructional design and relevant implementation, which requires appropriate comprehensive support for professional and personal development.

Technology and digital media supports effective teaching and learning processes while at the same time having a sufficient impact on teaching style and instructional approaches. This is particularly important for the language class. The problem here is that, despite the obvious fact that language learning is mainly based on the professional skills of teachers and approaches to didactics, technology and digital media play an equally important role in language education. First of all, most modern approaches to instruction are highly interactive, and at the same time most of the content is digital or web-based. Moreover, technology is tightly integrated into the practice of educational approaches. As a result, a number of relevant digital competences are a must for a modern language educator.

The next issue to be mentioned is that, unlike other educational disciplines, language education requires specific approaches to pedagogy and instruction. These specific approaches focus on support for students' cognitive processes in an effective way, which requires the corresponding teachers' professional competences to be developed. These competences include, among others, competences in social and psychological communication, interaction and impact, oriented towards supporting and maintaining the cognitive processes already mentioned and linking these processes to relevant educational goals.

Finally, the scope and agenda of a language teacher's professional development is highly interdisciplinary in nature, as it includes not only specific language teaching issues, but also technology based instructional issues which should be focused on the highest level of teacher-students-content interaction and, as has already been mentioned, are based on sociological and psychological aspects of such interaction. Based on the above, the professional development of language teachers is quite specific and requires comprehensive approaches, both in terms of pre-service training and in-service training, development and retraining of teachers. Moving from the cognitive to the technology dimension, the most important aspects are students' engagement and motivation and the role of information and communication technology (ICT) in this regard, classroom management and ICT competences needed to support this management process, focusing on students and the general aspects of technological support for such student-centered instruction, enhancing student motivation and self-confidence through non-verbal communication, self-reflection of teachers and prospects for further instructional improvements.

In addition, some new developments in technology-enhanced education and education research should be mentioned. Such methods are based on advances in artificial intelligence (AI) and related educational applications and allow new approaches, including approaches to student performance assessment, to be introduced in the modern educational process. For example, advanced approaches to performance metrics aim to "optimize educational and academic activities in schools and institutions of higher education" [5] and at the same time impose additional requirements for teachers' professional knowledge, since additional competences in AI and machine learning approaches are required.

1.2. In-Service Teacher's Professional Development in Lithuania

In Lithuania, continuous in-service training is a professional duty, and participation in various methodological activities can give teachers an opportunity to present their professional development as an ability to integrate digital technologies into the curriculum and manage pedagogical processes supported by technology. The qualification of teaching staff in state (except for higher education institutions) and municipal educational institutions is developed according to regulations approved by the Ministry of Education, Science, and Sports. Continuing professional development programs are provided by continuing professional development institutions [6]. All teachers have the possibility to select and participate in in-service teacher training courses organized by regional teacher

education centers, teacher professional development centers or universities in order to improve their competencies.

"The Second Survey of Schools: ICT in Education study", conducted for the European Commission, presented an analysis of the results of a survey conducted in 2017–2018 of senior teachers, teachers, students and parents from EU28, Norway, Iceland, and Turkey. Amongst other results, the survey shows the situation of teacher's professional development in Lithuania related to ICT. It is worth mentioning that more than 9 out of 10 Lithuanian students across all ISCED (International Standard Classification of Education) levels are taught by teachers who engage in personal learning about ICT in their spare time. Every second Lithuanian student at all ISCED levels is taught by teachers who are involved in communities for professional developments with other teachers. Between 74% (ISCED 3) and 81% (ISCED 1) of Lithuanian students are taught by teachers who attended in compulsory ICT training. Between 52% (ISCED 1) and 42% (ISCED 3) of Lithuanian students are taught by teachers who have completed teacher training courses on ICT use. Between 21% (ISCED 1) and 16% (ISCED 3) of Lithuanian students have teachers who spent more than 6 days in professional development in ICT during the last 2 years. Only between 11% (ISCED 1 and 3) and 12% (ISCED 2 and 3) of Lithuanian students have teachers who report that they had no time at all to participate in ICT related professional development activities during the last 2 years [7].

1.3. Video Recording Feedback

The opportunity to analyze one's own behavior externally is an effective way to improve skills and abilities. Such self-reflection methods are indispensable for teachers who are in close interaction with young people and are responsible of their growth. Using video to reflect on and analyze teaching practice is a valuable tool in pre-service teacher education [8]. Video-based feedback promotes changes in teachers' behaviors in the class of different disciplines and of different students' age [9–11]. Video feedbacks are used in different ways in teacher development. Video records could be used with other tools such as video editing, video clubs, or journal writing, and also conferencing tools are important [11]. Videos of teaching practices can be watched and analyzed individually or in groups [9]. Video feedback is more effective when used with structured viewing guides [12,13] and can elicit stronger effects when combined with expert feedback [14,15].

The well-structured reflection on one's own teaching at teacher education promotes the development of a professional understanding. The analysis of teachers' lesson videos changes teaching skills and abilities. Video feedback can be a reasonable contribution towards raising teachers' quality of teaching [12]. Observation of recorded lesson videos can make them able to identify a particular practice they can changed later [16]. After the analysis of video feedback, teachers increasingly use open-ended questioning, showing increase in complexity and sophistication [10]. Video-feedback may be a powerful approach for increasing teacher's use of praise during classes [17]. The teachers appeared more stimulating in their behavior, were more sensitive and more verbally stimulating [18]. Video feedback promotes a change in preservice teachers' self-reflection [13,19].

Video-based peer feedback can help to promote teachers' professional vision of classroom management [19] and foster self-efficacy in classroom management by establishing competence support [15]. The teacher's self-development is an important skill that helps to improve teaching: to improve teacher's interaction with students [20], behavior [12], and linguistic skills [10]. Observations and self-assessments show that the teachers practiced considerably more of the teaching behaviors targeted [12]. The analysis of class videos can help teachers in classroom management.

1.4. Eye Tracking in Research

Eye tracking is a relatively new study method in education. The method is used for a wide range of research. Eye tracking has been used to improve the computer-aided learning and testing of educational environments, has increased the expertise for development in

visual domains, such as medicine or computer games, and has recently been also used to promote visual eye movement modelling examples [21]. The measurements of eye tracking are used for example to analyze how the process of the visual observation of multimedia content is produced, also to validate empirically aspects such as the understanding process of multimedia content and the attention of the pupils while analyzing the given resources or the cognitive load of the educational materials [22]. A suitable design of educational materials may favor the acquisition of information and knowledge by students [23].

Eye tracking measurements are used to inference about the cognitive processes of selecting, processing, and integrating [24]. Eye movement research is used to link ocular metrics to educational processes (e.g., reading, memory, training) [24–26]. Eye tracking shows the gaze proportions during teachers' gaze-attention for example, teacher questioning students, and being communicative for example when a teacher lectures students [27]. The gaze proportions of teachers with experience revealed prioritization of students, whereas novice teachers give priority to non-instructional issues such as teacher materials, computer, or other resources [27].

Eye tracking research also includes research aimed at the general professional competences of teachers [28]. The focus is on analyzing teachers' professional behavior, leading to improvements in educational methods and teaching practices. In addition, the application of eye tracking to the analysis of information processing patterns can be mentioned [29]. This is important since it presents an approach to evaluate a kind of a cognitive activity based on utilization of the number of mental models involved in a given cognitive process. The use of eye tracking allows the introduction of robust laboratory methods based on the measurements of a number of well-defined variables, such as eye movements (saccades) and gaze fixation, into the practice of educational research focused on cognitive dimension.

1.5. Class Interaction with Educational Technological Equipment

High-performing integration of ICT in teaching classes depends on a lot of factors. One of the important factors is knowledge and skills of teachers to appropriately apply ICT in classrooms [30–32]. When teachers have more experience of usage of Educational Technological Equipment (ETE), they can pay more attention on teaching and interaction with students. The teachers' ETE skills improve with teacher ICT training, availability of educational software, supportive collaboration among teachers, recognized self-efficacy, and influenced the teaching processes in classroom with use of technology [33,34].

The use of technology in class and out of class increases students' engagement or had a facilitator role in the development of students' engagement [35]. Teachers use technological tools to promote student-centered approaches leading to a better learner engagement with subjects and to increase learners' motivation to deepen their subject knowledge [30,36,37].

2. Materials & Methods

2.1. Research Objectives

The objective of this research is to present and test an integrated approach to the professional development of language teachers, with an emphasis on integrative instructional approaches and the use of an eye tracking system as the main technological tool. These integrative approaches are based on technology supporting interaction with both students and digital content. The focus is on professional development: (1) digital literacy skills for effective integration of multimedia and technology into the practice of instruction; (2) effective communication skills focusing both on psychological and sociological aspects of communication; (3) effective interaction skills, focusing both on personal and digital equipment interaction. The use of eye tracking enables a more specific and concentrated view on certain instructional aspects, such as inter-communication, interaction, class management and motivation, and feedback and improvements of class work.

2.2. Research Question

Teacher professional development, inspired by a cognitive-load-theory based instruction, should focus on linking relevant cognitive load instructional aspects to a set of practical steps to support related instructional efforts by integrating technology into the practical teaching process. Such integration is based on the development of a set of required skills and competences to effectively implement technology in the instruction process. As far as cognitive processes are concerned, the associated skills are individual, refer to personal characteristics and require rather than centralized, but mainly based on personalization and self-reflection, professional development programs to be developed. The relationship between the instructional effects [4], the skills required to effectively integrate technology into instruction, and ICT integration competences are presented in Table 1.

Table 1. Summary of effective technology implementation in cognitive load theory-based instruction.

Instructional Effect	Required Skills for Effective Integration of Technology into Instruction	ICT Integration Competences
Worked example	Timely transition from interpersonal to inter-technological sources of communication	General ICT competences and ICT usage in class; ICT integration and competences for classroom management; ICT integration for student engagement and motivation; ICT integration and support for student-centered education; Non-verbal communication; Self-reflection for improved teaching.
Split-attention	Managing and processing split-source interactive information	
Modality	Managing technology that supports consistent multimodal interaction	
Transient	Managing technology in a manner to support reduction of transiency	
Redundancy	Managing the clustered information on request and in real-time	
Expertise reversal and element interactivity	Content personal adaptation and interpersonal communication skills	
Working memory depletion	Skill to form, prioritize and dose instructional chunks	

The research question is as follows:

How can eye tracking be used as a technology for the professional development of a language teacher focusing on the effective technology implementation in a cognitive load theory-based instruction?

To answer the research question, the following aspects needed to be studied: (1) General ICT competences and competences for *classroom management*; (2) ICT usage in the class and the role of ICT in ensuring *student engagement and motivation;* (3) *Student-centered education* aspects as related to supporting language instruction through ICT; (4) Eye-gaze and *non-verbal communication* in the language class; (5) *Self-reflection* and improved teaching.

2.3. Research Methodology

Research method utilized in this study is a mixed qualitative–interpretative research [38] based on a comparative case study of a number of language classes (including six language teachers and 81 students) in a secondary school setting. The data collection includes (1) digital data based on the results of the eye tracking measurements and (2) qualitative data based on qualitative interviews. A brief overview of the research methodology can be described as follows: (1) examination of various digital data sets obtained from the eye tracking system recorded in the practical training of teachers with different levels of digital competence; (2) provision of feedback to participating teachers in the form of subsequent comparative examination of collected eye tracking data; (3) conducting qualitative interviews with teachers that encourage self-reflection and motivation for self-improvement;

(4) analysis of collected data and qualitative interviews with education policy experts to examine the impact and possible approaches to training language teachers.

The study consists of three stages: (1) eye tracking video recording, (2) video observation and interviewing of teachers, eye tracing and self-reflection of video recordings, and (3) expert analysis based on video material. The focus group of the study includes teachers of language (English, Lithuanian, and Russian) of Lithuanian junior secondary school. The purpose of monitoring data collection and analysis is to facilitate the process of interviewing of language teachers' self-reflection when implementing ICT into classroom activities. This (non-random, convenience) sample of teachers consisted of two subgroups or subsamples: (1) expert ICT users (control group) and (2) novice ICT users (focus group) (hereinafter referred to as "expert" and "novice"). During the data collection process, a certain number of lessons and teachers were recorded: four lessons by three pairs of teachers working in the same school (six teachers in total and 24 lesson recordings).

Teachers and recorded lessons met the following conditions of the experiment:

- The pair of teachers consisted of one expert and one novice;
- The teachers were paired according to the subject matter of their teaching;
- The teachers were also paired in their classes. Both teachers have to teach the same grade of students;
- Recorded lessons have also to be on the same topics.

The research sample consisted of:

- Two Lithuanian language teachers (first language, L1);
- Two Russian language teachers (second language, L2); and
- Two English language teachers (third language, L3).

In order to ensure cross-teacher comparability and to improve the elimination of confounding variables, the topics and content of the lessons were as synchronized between teachers of a given pair as possible. In total, 23 lessons have been recorded.

Results of eye tracking data consist of three subheadings, namely: interactive whiteboard analysis, horizontal classroom analysis and vertical classroom analysis. Each subheading includes eye tracking variables such as number of visits, time to first fixation, number of fixations and duration of fixation.

- Number of visits (NV): the measurement of the number of visits within the active Area of Interest (AOI) or AOI group.
- Time to first fixation (TFF): the measurement of how long it takes before a test participant fixates on the active AOI or AOI group for the first time.
- Number of fixations (NF): the measurement of the number of times a participant fixates within the AOI or AOI group.
- Fixation duration (FD): the measurement of the duration of each participant fixation within an AOI (or within all AOIs which belong to an AOI group).

When considering the variables of the study, it is important to clarify the following aspect. The set of variables presented supports a kind of mapping of the subject's cognitive domain into the domain of ITC integration competences, which is the subject of our study. The following is a specification of areas of interest (AOI). Classroom area with students (considered as group area of interest AOIGC); vertical and horizontal classroom areas (three vertical areas, three horizontal areas AOIV1-3, AOIH 1-3); separate classroom bench areas (number of areas equals number of benches, AOIB1, . . .); individual student areas (number of areas equals number of students in class-AOIP1, . . .); area of other interests (group area not related to the educational environment—windows, door, outside, AOIGO); interactive whiteboard area (AOIIB), blackboard area (AOABB), teacher table area with ICT equipment (treated as a group area, AOITT), teacher personal computer area (keyboard) (AOITC), teacher monitor area (AOITM). Table 2 presents the relationship between ICT integration competences and eye tracking variables.

Table 2. ICT integration competences and eye tracking supporting variables.

ICT Integration Competence	Primary Areas of Interest	Eye Tracking Variables Supporting the Competence
General ICT competences and ICT integration and usage in class	AOIGC, AOITT, AOITC, AOITM AOIIB	Regarding the AOITT area, NF is in favor of AOITM compared to AOITC. This optimizes the time to process information and minimizes the teacher's interaction time with the computer. NV and FD in AOITT are small compared to other areas. This reduces the time for non-teaching activities and indicates sufficient ICT proficiency. NV in favor of AOIB compared to AOITT.
ICT integration and competences for classroom management	AOIGC, AOIV1-3, AOIH 1-3, AOIB…, AOIP…, AOIIB	The NV for the different subject areas is balanced. This allows for an even distribution of attention among the students during the lesson. The same applies to FD, but some variation is allowed as different "problem" areas require additional attention from the teacher. In interactive whiteboard-supported learning, subject areas are favoured for NV, allowing for classroom management activities.
ICT integration for student engagement and motivation	AOIGC, AOITT, AOIIB, AOIGO	TFF in favour of subject areas over ICT-related areas. TFF in favour of AOIIB over other ICT-related areas. This allows for earlier engagement and motivation of students. NV in favour of classroom areas compared to AOIGO area, supporting an active teaching style.
ICT integration and support for student-centered education	AOIGC, AOIIB	FD of AOIGC and AOIIB are balanced in support of an interactive teaching style that engages students in activities during the lesson. NV is in favor of interactive classroom equipment over assistive ICT equipment for the teacher. This allows the focus to be on the learning process itself, avoiding additional activities such as managing the ICT equipment.
Non-verbal communication	AOIV1-3, AOIH 1-3, AOIB1-…, AOIP1-…	TFF differences on different subject areas should be minimized and NV and FD balanced, maintaining an even distribution of attention.
Self-reflection for improved teaching.	Different class areas of interest	A self-reflective comparative analysis of the results of the experiment (all variables are involved). The comparative study is conducted in the following dimensions: (1) within the same lesson; (2) between lessons of the same teacher; (3) between teachers/lessons of the same subject; (4) between different subjects. This allows for the adoption of advanced teaching styles and the use and personalization of best teaching practices.

For this experiment, we employed Tobii Pro Glasses 2 eye tracking glasses supported by Tobii Glasses Controller software and gaze data analysis using Tobii Pro Lab 1.86. state-of-the-art equipment provides high accuracy in measuring variables. When it comes to measurement accuracy, several key points should be highlighted. Firstly, the technical parameters of the equipment provide certain measures of accuracy and precision, with *accuracy* defined as the average difference between the fixation target location and the measured gaze location on the screen, and *precision* defined as the ability of the eye tracker to reliably reproduce the same gaze point measurement [39]. These technical parameters are maintained and supported by the equipment manufacture [40]. Further, certain settings of the experimental conditions (controlled environment) are important. Conditions such as lighting and equipment location should be provided in real school classroom conditions, as opposed to laboratory conditions, requiring considerable effort to perform and maintain. Finally, the qualifications of the experimenter should ensure a certain level of competence in the use of the equipment, as required by the specification and guidelines. This was

ensured by thoroughly instructing the participants in the experiment and by carrying out several trials before the actual recordings. Further technical details of the experiment are presented in Appendix A, Appendix B, Appendix C, sections "Equipment and recordings" and "Data analysis methods".

3. Results

3.1. Experiment Settings

After collecting data with the aid of eye tracking glasses, heat maps and gaze plots were exported for each recording taken during the lectures. These heat maps and gaze plots show the eye movement and eye contact attitudes of the teachers during each lesson. Two main views were taken into consideration when analyzing the teachers' eye movement data, namely the view of the board and the view of the classroom.

Firstly, as shown in Figure 1, a scene with a clear view of the board was taken and analyzed using the eye tracking software. According to the analysis, the eye movements of teachers on the board during the lectures were exported in the form of heat maps (Figure 1, left) and gaze plots (Figure 1, right). While a heat map is a kind of visual analysis that uses colors to show the activity of the users' eye movements on the respected screen, a gaze plot visually shows the gaze patterns.

Figure 1. Sample heat map (**left**) and gaze plot (**right**) for board analysis.

Secondly, a clear scene covering the entire classroom was taken, as can be seen in Figure 2. Heat maps (Figure 2, left) and gaze plots (Figure 2, right) were then exported for each teacher and each lesson were exported to show the movement of the teachers' eyes throughout the class.

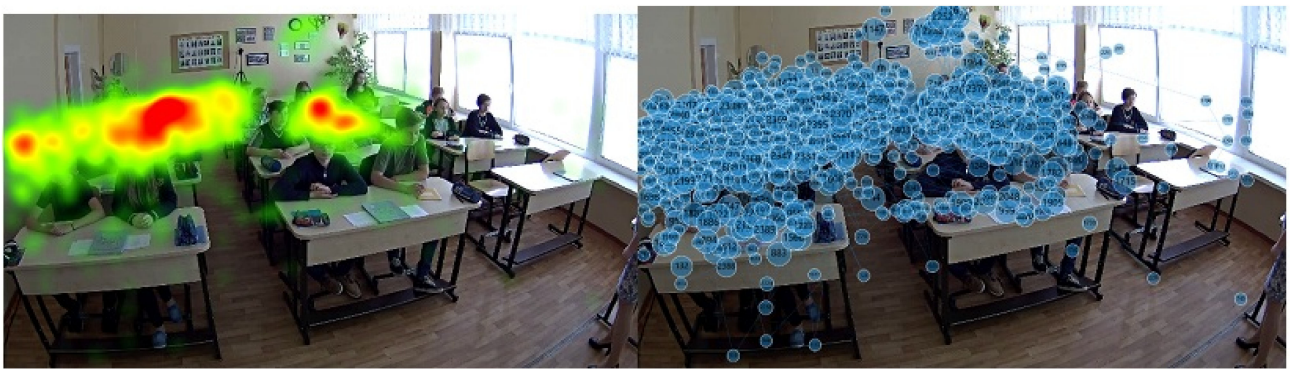

Figure 2. Sample heat map (**left**) and gaze plot (**right**) for classroom analysis.

Lessons were recorded for students in grades 6–8 (12–15 years old). We chose the following coding system. The participating teachers were coded: the first letters stood for teachers (T), the second for the first letter of the subject (English, Lithuanian, or Russian),

and the third for "expert" or "novice". For example, T-LE is the Lithuanian language expert teacher, and T-LN is the Lithuanian language novice teacher. Interview excerpt are coded with the teacher code, the letter E and the excerpt number. For example, T-LE, E1 means interview excerpt number 1 for this particular teacher. The topics selected by the participants for the recorded lessons (lessons were synchronized in pairs) as shown in Table 3.

Table 3. The number and topics of recorded lessons.

Lesson	T-LE	T-LN	T-RE	T-RN	T-EE	T-EN
Number of recordings	4	4	4	3	4	4
Lessons topics covered	Grammar: verbs	Literature: analysis of the work of the Lithuanian author	With whom we are friends? Grammar	Friendship. A song for the 3rd grade pupils entitled "The friendship is not a work"	Myth and legends	Grammar: revision of Past Continuous
	Literature: analysis of the work of the Lithuanian author	Grammar: a Verb	Portrait of a friend. Grammar	With whom we are friends? Grammar	Grammar: negative form, positive form, and questions	Breaking the low. Vocabulary, text understanding
	Grammar: Nouns	Literature: artistic expressions to describe the nature in works of literature.	Searching for a friend. Grammar	Portrait of a friend. Grammar	Reading and understanding the text from textbook	Biography of famous people I
	Literature: artistic expressions to describe the nature in works of literature.	Grammar: a Noun	True friend	-	Writing biography of famous people	Biography of famous people II

Most teachers used multimedia projects because they had this opportunity (Table 4). Only T-EE used tablets and a computer lab (classroom) as she was really engaged in using ETE in the classroom. Other teachers did not have tablets in their classes. A total of six teachers of Lithuanian (L1), Russian (L2) and English (L3) language took part in the lessons. There were two teachers for each course, one expert and one novice teacher. These teachers gave on average 40 min and 45 s of lectures during the 4 weeks of data collection process.

Table 4. Number of students in the recorded lessons and equipment used.

Lesson	T-LE	T-LN	T-RE	T-RN	T-EE	T-EN
Equipment used	Multimedia projector—presentation, video	Multimedia projector—presentation and video	Multimedia projector—presentation, tasks	Multimedia projector—video clip	Multimedia projector—interactive material, video, material from websites, tablets	Multimedia projector—interactive educational material
Number of students by lesson	14	19	8	9	12	9
	14	19	9	10	12	12
	13	17	10	9	12	11
	13	18	7	-	12	11

3.2. Eye Tracking Results

3.2.1. Interactive Board Analysis

Table 5 presents data on the results of eye movements relating to the interactive whiteboard and blackboard and their percentage to each other.

Table 5. Average visit count and fixation duration on board.

Teacher Code	Average Visit Count on Board		Average Fixation Duration on Board	
	Interactive Board (%)	Black Board (%)	Interactive Board (%)	Black Board (%)
T-LN	75.00	25.00	75.00	25.00
T-LE	95.00	5.00	94.69	5.31
T-EN	89.04	10.96	92.17	7.83
T-EE	76.91	23.09	87.03	12.97
T-RN	88.16	11.84	98.55	1.45
T-RE	82.95	17.05	90.23	9.77

3.2.2. Horizontal Layout Analysis

Table 6 presents the results of eye movements for the horizontal line in the classroom, which provide data on the front, middle and back sides of the classroom and their percentages to each other (see Figure 3).

Table 6. Average visit count and fixation duration among horizontal layout.

Teacher Code	Average Visit Count			Average Fixation Duration		
	Front (%)	Middle (%)	Back (%)	Front (%)	Middle (%)	Back (%)
T-LN	31.73	39.93	28.34	33.73	41.53	24.74
T-LE	21.06	47.90	31.04	21.32	51.45	27.24
T-EN	26.35	34.16	39.49	25.37	34.85	39.78
T-EE	15.55	41.47	42.98	19.14	35.31	45.56
T-RN	14.38	35.86	49.76	13.59	36.66	49.75
T-RE	19.25	29.18	51.57	19.80	34.83	45.38

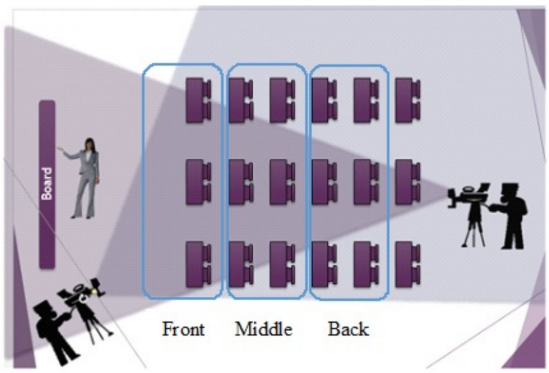

Figure 3. Eye movement results for horizontal line.

3.2.3. Vertical Layout Analysis

Table 7 presents the results of eye movements for the vertical line in the classroom, which provide data on the left, middle, and right sides of the classroom and their percentages to each other (see Figure 4).

Table 7. Average visit count and fixation duration among vertical layout.

Teacher Code	Average Visit Count			Average Fixation Duration		
	Left (%)	Middle (%)	Right (%)	Left (%)	Middle (%)	Right (%)
T-LN	61.34	32.53	6.14	63.89	31.07	5.04
T-LE	9.93	31.13	58.95	6.15	22.56	71.30
T-EN	58.05	26.60	15.35	55.93	30.01	14.06
T-EE	59.30	23.66	17.05	58.28	22.62	19.11
T-RN	43.07	14.70	42.23	47.37	11.33	41.30
T-RE	75.12	9.93	14.96	82.96	5.92	11.11

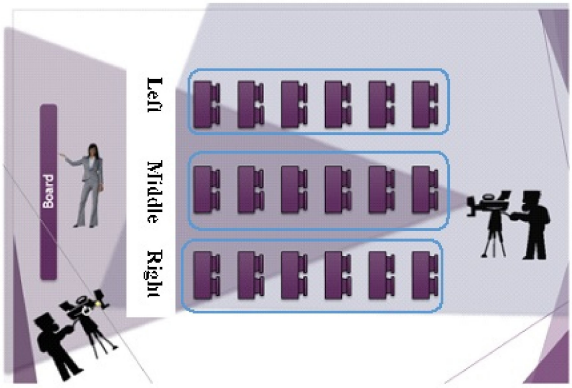

Figure 4. Eye movement results for vertical line.

4. Discussion

4.1. Professional Development through Self-Reflection

The recorded lessons were observed by the focus group teachers to analyze their own behavior as well as that of their colleagues in the control group. The main purpose of the observation was to explore aspects of the practice of interacting with the technologies available in the classroom. In addition, we wanted to examine the use of educational technology equipment (ETE) and the overall strategy of language teaching in a typical Lithuanian public primary school.

Expert teachers from the control group felt more comfortable using ETE in the classroom and they looked at the screen when needed. They focused on the pupils' work and tried to catch their understanding of the lesson. The material selected and prepared using ETE is more structured and easier to understand by the students. Experts often find more interesting materials, videos, assignments, and texts. Novice teachers in the focus group were on the other hand often involved with textbooks and did not deviate from the topic. Usually, they took care of what they wrote in presentations and showed on the screen. The eye tracking showed that they looked at the screen more often.

The number of pupils in the classrooms in this study was relatively small. The atmosphere of teaching and learning in such classes differs from the methodology used in bigger classes. Teachers in small classes are able to observe pupils better and notice more details in their learning behavior, pay more attention to each pupil and help individually. The recordings also had a certain impact on teacher behavior. Teachers were stressed out as soon as they started wearing glasses. They also had to prepare pupils in advance. At the beginning of the recording, pupils also felt uncomfortable. At the end of the recording, however, they felt relaxed and the tension remained very low: "It was a challenge for both me and the students to be observed. Students were strained, but after four recording lessons, all of us felt better." (T-LN, E1); "I think the recording had an effect on our emotions. I was stressed and the students also behaved not as usual." (T-RE, E1).

The school chosen for the experiment uses computers and a projector as an example of technological equipment for teaching. During the recorded lessons, teachers used a computer connected to the Internet, showed videos and their own presentations or other mainly text-based material. The school has a 3D classroom. One of the experiment participants had tablets in the classroom. Observation of the recordings allows for better preparation for a teacher interview, one of the aims of which is to find out the reasons and motivation for teachers' behavior, the preferences associated with the use of the ETE, and the differences and similarities between an expert teacher and a novice teacher.

Four topics were selected for the interview: (1) motivation of teachers and students to use ETE, (2) classroom management, (3) use of electronic materials, and (4) use of equipment in the classroom.

4.1.1. Motivation

Almost all the teachers surveyed believe that the ETE helps to focus the attention of students. Pupils like everything about computers and the use of technology is more attractive to them than traditional lessons where the teacher mainly talks and gives information in a passive way: "[...] also about the concentration of students' attention, the learning process becomes more interesting." (T-LE, E1); "Such lessons are more interesting for students and they can concentrate their attention when using ICT because for today's student actions and turning activities are important." (T-LN, E2); "The elder students also like technology supported lessons, because the lessons become more attractive, students gain better motivation for learning, and their abilities to remember increase." (T-EN, E1); "I think that ICT makes lessons more attractive [...] The delivered material is more interesting and varied, and student have to concentrate their attention" (T-RN, E1).

However, one expert noted that ICT alone is not a motivating tool for good students to motivate them to study for a longer period of time: "I think that highly motivated students do not need additional attraction because they are motivated by the process of learning itself, by new knowledge. Students with very low motivation on learning are usually not interested in ICT usage at lessons either." (T-EE, E1).

Experts and novice teachers agreed that ETE helps pupils to memorize material through attractive presentations, videos and dynamic assignments. Presentation of a topic from different perspectives is also important for motivating students and their participation in the lessons: "The students can remember more when ICT is used." (T-LN, E3); "ICT has impact on students' ability to memorize, we have noticed that when we had worked with a database on literature topics and analyzed the resources using only ICT, doing work in group, visiting virtual museums." (T-LE, E2); "Earlier, about 30 years ago, students who had good visual memory remembered much better what was written in textbooks. Now we have a bigger variety of materials to present to students." (T-EN, E2); "I think students have to get various activities during lessons." (T-RE, E2).

An expert English teacher believes that teacher motivation is very important in the lesson. It is much better when the lesson is interesting for the teacher as well. In addition, the teacher's inner position is very important to attract pupils' attention and mobilize their thoughts: "ICT in the lessons makes me feel better. I have more possibilities to choose tasks. Tasks can be more different than usual, not necessary from the text book. Sometimes the tasks in textbook iterate or are very similar because they are created by the same authors. [Using the internet], I can choose more interesting tasks." (T-EE, E2).

Sometimes multimedia helps teachers, especially when there is a lack of material in textbooks or no textbooks at all on certain topics. Teachers use ETE *to introduce and present material*. At the same time, ICT helps to *personalize the learning process* so that students can learn at their own pace: "I try to personalize tasks for students. I give complex and deeper tasks for advanced students and easier tasks or additional tools for the rest of students." (T-RE, E3); "When we have complex text in foreign language, some of the students lose their attention because of not understanding. I try to solve this problem by choosing a text suitable for most of the class." (T-EN, E3); "I take students to computer class when they

need to search information by themselves. Usually, they work individually. [...] I like also to take students to computer class when they have to improve a language grammar knowledge and can work at their individual speed." (T-EE, E3).

4.1.2. Classroom Management

Novices usually believe that ETE *helps to manage (control) a class*. Some teachers believe that students are more focused and involved with the ETE during lessons: "I think it is easier to supervise students when ICT is in use because students are more concentrated and focused when watching a video or a presentation." (T-LN, E4).

On the contrary, experts believe that lessons using ETE are nothing special and usually have no impact on classroom management: "The ICT usage did not make any impact to manage the class. I like discipline and students know it. We have rules on what to do and what not do, and discipline in classroom hasn't depended on ICT usage. So, I do not feel any ICT challenges in this case." (T-EE, E4).

We have assumed that novice teachers *use eye contact to solve students' behavior problems* in the classroom. The recorded lessons confirmed this assumption. Eye tracking shows that some teachers focus their eyes on one side of the classroom or on specific students. The teachers explained that pupils with teaching or behavioral problems usually sat in such places.

The second assumption of this record observation was *that experienced teachers distributed attention to all students* and took care of them more evenly. However, examination of eye tracking data shows that expert teachers also look at one side of the classroom to a larger degree. Sometimes they have to help individually, repeat the task and give more time to do the task properly. However, the second assumption has not been confirmed. The eye control data showed that all teachers gazed to a larger degree at students with behavioral problems or at students who were not gifted.

4.1.3. E-content Material Usage

Experts and novice teachers of Lithuanian and Russian *did not have specific, previous teaching material* for lessons using ETE. They had to prepare all the material for multimedia from scratch themselves: "It is a useful situation, there still a serious lack of educational software for learning and teaching Lithuanian language. There are no textbooks to help integrate language education with ICT." (T-LN, E5); "Now we have got new textbooks, but there are no tasks on new topics. We have to prepare these topics in advance and collect tasks on data bases by ourselves." (T-LE, E3); "We do not have any digital material prepared in advance for lessons. Usually, we have to collect resources on internet and adapt material by ourselves [...]. We have some tasks for listening but records are of very bad quality and I don't use them. I think it is better to listen to me than to these records. Of course, we can find some records online, but often it is difficult to find suitable ones for the topic." (T-RE, E4).

On the contrary, this did not embarrass the experts much. In fact, they don't care much about it and they don't have any difficulty preparing materials for ICT on their own. As a rule, an experienced English teacher likes to prepare his own lessons: "I use ICT for teaching grammar in all grades, also for analyzing literature works of foreign writers in all grades. I also like to give homework for students based on ICT." (T-LE, E4); "I am using electronic textbooks to all youngest and eldest students. I like to use YouTube videos also. Sometimes I succeeded to find good resources which fits to my idea. Usually I do not use what the official web portal of the Education Development Centre recommends. I found several language grammar websites that are suitable for me and for students." (T-EE, E5).

Teachers take care of the consistency of the educational material. When using ICT material, it must be integrated into all topics. In most cases, however, there is no such ready-made consistent material for all subjects. Pre-prepared *assignments for using ICT and integrated with textbooks* are available for the English lesson. The material is consistent and contains instructions for teachers. This makes it easier for teachers, especially those starting

to use ICT in the classroom. Teachers do not need to spend a lot of time searching for materials on websites or preparing for the lesson lessons: "There is no prepared systematic learning material (audio or video) for Lithuanian language. However, we have some tasks in EMA (online material for different subjects for Lithuanian language) worksheets." (T-LN, E6); "I have a very good textbook with digital material, where each task can be shown using a computer. We have digital material for each lesson. [...] I have also the teacher's book including goals description, videos, games, and recommendations." (T-EN, E4).

Both type of teachers, the experts and novices, have agreed that e-material *gives more opportunity* for teaching and learning. The students can be engaged when using more various activities. Using several different sensations (to see and to hear) in the learning process is good for students. However, some of the novice teachers have doubts about usage of ICT in the classroom: "I think we have to use ICT very carefully. I mean we have to think about the benefits for the students. Does ICT help students or disturb them, could it confuse students?" (T-LN, E7).

4.1.4. Eye Tracing on the Interactive Board

Observing recorded lessons suggested that both novice and expert teachers look at the interactive screen for a larger amount of time than at the blackboard. This makes sense, because all teachers are language teachers and they did not have to explain anything on the blackboard to the students. They all prepared materials in advance in the form of Power Point presentations or used other electronic content. A distinctive feature of LE teachers is the eye tracking results. The teacher looked at the interactive screen about 45% of the time with a fixation duration of about 45%, while the number of visits of another teacher was over 75% with a fixation duration of 75%. However, this can happen because the multimedia screen was at the top of the board (Figure 5).

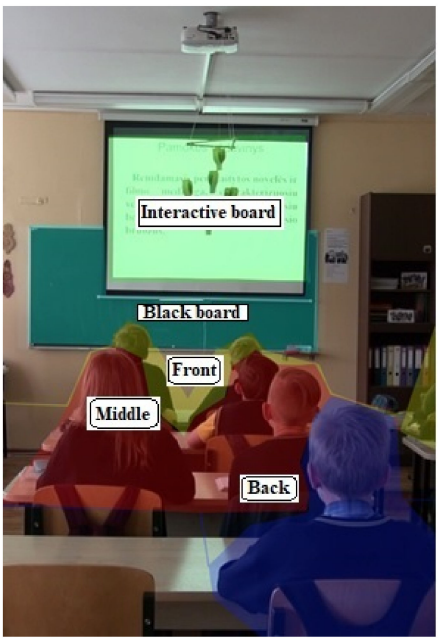

Figure 5. The class environment.

4.2. Policy Makers' (Educational Experts') Observations and Recommendations

4.2.1. Introduction

Three experts from different institutions in Lithuania analyzed the video recordings: (1) an expert working in the field of teacher education with a focus on mathematics and technology, (2) two university researchers who are engaged in research on technology enhanced learning from different perspectives and are involved in improving teacher training programs.

Each of the experts studied the lessons of the first and last week of two teachers of the same discipline in order to identify differences in teaching approaches. At the same time, the experts took detailed notes and provided reviews of their observations. They also examined the positive and negative elements affecting the class dynamics that they encountered during the review.

The experts were asked some questions to support the different perspectives:

1. What do you think about using technological equipment and e-learning materials in the course you are viewing?
2. Did the teachers use various technological equipment in the video you observed? If so, how has this technological equipment been integrated?
3. In your opinion, has the use of an eye tracking device and recording of the course affected the course?
4. How do you evaluate the course you are looking at in terms of using technology, and classroom management, taking into account the lessons you have already been following?

An external expert is labelled by E, subject letter (L—Lithuanian, R—Russian, and E—English) and the last letter refers to N—novice teacher's lesson record and E—Expert teacher's lesson record. For example, E-LN means an expert, who observed records of a Lithuanian language novice teacher. Interview excerpts were coded with the letter E and the excerpt number. For example, E-LE, E1 means interview excerpt number 1 for this particular expert.

4.2.2. Use of Technological Equipment and e-Learning Content

The experts have noticed that novice teachers mostly did not feel comfortable with computers. They looked tense and often did not use all the educational opportunities that a computer can provide. The teachers used simple presentations using mainly textbook materials: "Teacher wanted to show that she can use computer, she open audio record (song) and ask students to listen. However, she didn't make any stops to listen to parts of the song or phrases to pay attention—it shows that the teacher is not very comfortable with computers. [...] Teacher used the computer and projector in a simple way. She didn't open any e-learning content in the internet." (E-RN, E1); "E-content was limited to PowerPoint slides that teacher used to present material from, show questions, etc. and video (multiplication film) created according to the literature piece studied during the lesson." (E-LN, E1).

On the contrary, expert teachers felt more comfortable working with the equipment in class. The computer is a tool that helped the teacher to improve pupils' abilities and also gave the opportunity to use more modalities (see, listen, read) to present learning material: "The teacher behavior shows that she is fluent with technology: she switched screens while talking (mostly in Russian) and answering students' questions. [...] The teacher used technology in more natural way [...] The expert teacher can use technology while talking and explaining their actions or content." (E-RE, E2); "During next lessons PowerPoint slides were more enriched with images (possibly, due to the topic, e.g., Nature description)" (E-LE, E2); "The teacher professionally manages the learning process that takes place in a computer class. The teacher feels very comfortable in applying the technology" (E-EE, E1).

The electronic content was not directly represented in the records. Such content was limited to PowerPoint presentations, some videos from the internet, and textbook-based exercises. Students in a computer lab used MS Word to write a famous person's biography and used an online dictionary: "E-content was limited to PowerPoint slides that teacher used to present material, show questions, etc. and video (multiplication film) created according to the literature piece studied during the lesson" (E-LN, E3); "In addition to teacher equipment, computer class students use online resources to prepare classroom lessons" (E-EE, E2).

4.2.3. Different Technological Equipment Integration and Effects of Eye Tracking Device

Teachers used only multimedia, and this was integrated into the training process. But the use of equipment looked natural in both expert and novice lessons: "Besides camera and glasses that were used for research purposes, multimedia projector and desktop computer for teacher were used during the lessons [...] Technological equipment and its integration doesn't change during all recorded lessons" (E-LN, E4); "I did not see a different equipment other than the glasses and the computer with projector" (E-RE, E3); "In fact, the only equipment in the "traditional" class is an interactive whiteboard that connects to the teacher's computer. The teacher is very skillful in using these devices in conjunction" (E-EN, E3).

Video recording and eye tracking glasses affect the teacher's behavior. Novice teachers felt unnatural and nervous. However, in the last recorded lessons, they felt more comfortable with glasses and recording: "The teacher was more comfortable with the glasses in a final lesson. However, she still felt tension of recording [...] The teacher stated that she is not comfortable with glasses. I do not think this affected the course of the lesson" (E-RN, E4); "Due to lesson video recording, some tension is observed from the side of the teacher, as well as students. [...] During the next lessons, the teacher is much more confident with the glasses she wears" (E-LN, E5); "There are some tensions and differences when compared with the usual lessons in the learning style, especially in the first recorded lesson. [...] At the end of the project, the teacher's stress almost disappeared, and the teacher feels comfortable using eye tracking and video recording" (E-EN, E4).

Expert teachers also felt a little unnatural and stressful with their glasses. For them, however, it looked as if the impact on the pupils was different. They spoke more than usual and were more active in class. Some observers noticed that this kind of change in the teacher's behavior made the pupils inactive: "I think because of the recording the teacher talks more than she talks normally, therefore she intervenes more and this makes her prevent the students to participate in class or support each other" (E-RE, E5); "It seems that in the beginning of the lesson, the speed of the teacher's speech and lesson activities is faster than normally, due to eye tracking device and course recording" (E-LE, E6); "At the end of the project, the teacher's stress almost disappeared, and the teacher feels comfortable using eye tracking and video recording" (E-EE, E5).

The pupils were nervous and seemed to be more silent than usual. However, some teachers tried to make the students more comfortable and helped them forget the recording. Towards the end of the recording, however, pupils became more active and natural: "Students were a bit stressed by the recording" (E-RN, E6); "Students got used to the recordings quite quickly, and it seems that there is no, or only a small, difference in the behavior of the students compared to the usual lessons" (E-ER, E6); "During the first lesson, only some students sometime seem to be shy due to video recording. The teacher tries to activate and speed up students, so that they are totally involved in the lesson activities and forget to think about the video recording" (E-LE, E7); "During the next lessons, students become used to the video recording, appear to feel comfortable, and are much more active to raise hand and ask questions" (E-LN, E8).

4.2.4. Assessment of the Course in Terms of Technology Use, Classroom Management

The students were not *actively involved* in the learning process. When students were silent, the teacher felt a bit confused: "Students are not given any parts in activating learning environment. Students were not asked to participate in using technology at all." (E-RN, E7).

Novice teachers *did not believe that ICT can improve* students learning. The teacher only used text, and there was no interactivity or teacher creativity observed. The methodology used by the novice teachers was *quite limited and teacher-centered*. The teacher often refers to the external motivation of the pupils, giving them an extra point for this: "It seems that teacher doesn't believe that technology can help to make better education—she is very

comfortable with a textbook and doesn't need anything else [...] I can see that the teacher was not prepared how to integrate technology more effectively in teaching" (E-RN, E8).

The methodology used by novice teachers was quite limited and teacher-centered. The teachers often refer to external students' motivation by giving them an additional point: "A teacher-centered model is dominated. Students are not allowed to discuss or ask each other for help. She is using the same teacher-centered approach when applying technology." (E-RN, E9); "The mostly used methodology by teacher is explanation (teacher's monologue), watching and commenting video, questions to the whole class, questions/tasks to students individually. [...] In order to activate students, teacher several times reminds them that for their answers to the questions, they will receive additional points. So, the teacher addresses the students' external motivation." (E-LN, E9).

The expert teacher *felt the class behavior* and notified the pupils in time. The teacher did not feel stressed when pupils were silent. In general, classroom management is different from that of a beginner teacher. The expert teachers used ICT in different parts of the lesson. *Electronic content was adapted to improve pupils' exact abilities* (to learn words, to practice grammar, to listen and understand, and to make decisions). The expert teacher is more creative in using clean technologies (projectors) in teaching and learning: "Using the projector to show certain basic concepts and request students to answer, affected positively the classroom" (E-RE, E10); "In some lessons, the teacher uses pair work when students exchange text they have written and make some assignments with their friend's text" (E-LE, E10):

The methodology used by expert teachers *enabled pupils to participate more actively in the lesson*. Teachers compared students' work, went back to previous work and made changes to what was a good teaching process: "Since the students solved exercises and were more concentrated when the computer was used they were more active and participated more. I observed that their attention was focused on the screen" (E-RE, E11); "Expert teacher's lessons are very interactive in terms of methodology. She poses good questions, notices students that need help, ask students to correct their errors, use students' self-assessment methods" (E-LE, E11).

The experts gave little advice to novice teachers regarding the teaching methodology. They noticed that novice teachers did not use possible ICT opportunities for teaching pupils. The lessons they recorded also left a feeling that teachers did not think about the meaning of the e-content used and about ICT in general. It seemed that teachers only use ICT if they are asked to do so: "The teacher must do a class design, determining which learning material is used and when it's used in the class. She has to integrate the materials to the class. Otherwise, there's no structure. And this causes students a difficulty in structuring" (E-RN, E12); "In the first lessons, teacher did not use any opportunity to organize group work, unless the topic of the lesson (discussing characters of the novel) is very suitable for pair/group work" (E-LN, E12); "It was quite strange to hear that teacher presents students with the aim and tasks of the lesson in a style that is usually used in education standards or lesson plans that are addressed to teachers, researchers, administration, etc., but not for students" (E-LE, E13).

As an additional remark, experts noted that teachers of foreign languages speak too much in their native language in their lessons. The experts suggested that teachers should speak more in the foreign language during these lessons to improve teaching.

4.3. Additional Topics

When comparing the study presented with similar studies carried out previously, a couple of additional remarks should be made. The presented study focuses on a comprehensive and integrated approach to the professional development of in-service language teachers using the eye tracking method, which provides a new angle to the problem. We have concentrated on the following aspects: First, we analyzed the topic of in-service teacher education as applied to language teachers. Then we focus on the integration of ICT in teaching practices. Finally, we explored the application of eye tracking in educational

research. All of these aspects are important in educational practice and are of interest to educational researchers and practitioners.

When discussing research on language teacher education, it is important to note that there has been a shift from top-down approaches based on centrally determined curriculum [1] to approaches focusing on the cognitive dimensions of teachers [41], and this study is in line with that tendency. We promote a personalized approach to education, especially considering the technology-supported learning aspects associated with a largely non-technically backgrounded audience such as language teachers.

Following this, when considering the integration of ICT, it is important to note that one cannot simply transfer general ICT integration practices to the language domain [42]. More subtle approaches are preferable. This study contributes in that direction. We promote a holistic approach, involving multiple actors, including students and colleagues, which provides additional motivation and feedback for more effective training outcomes.

Regarding the application of eye tracking in educational research, its applications to language teacher training as compared to teacher training in general is still under development [43]. While there are visible similarities in general ideas and methods in terms of measurement methods, variables and approaches, the most notable difference is that these approaches treat the teacher as a test subject, as opposed to our approach in which we support the teacher's role as a tester. This promotes person-centered approaches to professional learning, which is particularly important for such a complex field as ICT-supported language education.

5. Conclusions

The study developed and tested an approach to the professional development of language teachers. We used an eye tracking system within the class setting and appropriate self-reflection of the recorded data, which helps to improve the teaching style and motivation in connection with the introduction of ICT in classroom practice. At the same time, the study made a number of important contributions to the literature on language teachers' professional development. First, we are moving from laboratory studies to real-world classroom setting. Secondly, the relation between eye tracking and ETE use in the classroom was investigated. Thirdly, eye tracking was combined with self-reflective interviewing of teachers and feedback from educational policy experts for concluding observations and recommendations. All of this provides a practical example of the use of the self-reflection method for the professional development of language teachers, related to the set of skills and competences in the use of ICT and related language-class management.

Overall, it can be concluded that the result obtained allowed us to outline pathways to improve professional education for in-service teachers in the following directions: (1) ICT competencies, including additional competencies in the tasks and methods of eye tracking technology; (2) The use of ICT in the classroom in relation to instructional approaches and how eye tracking as part of teacher training and related feedback can improve teaching practice; (3) Student-centered education and educational methods in general in relation to the application of eye tracking research to support in developing more effective educational approaches; (4) Non-verbal communication as an important part of classroom management, related to the application of eye tracking to improve the personal student-teacher communication style; (5) Self-reflection plays a vital role in improving classroom performance, considering eye tracking as a means for reflection and feedback on the communication process between the teachers themselves and between teachers and students.

5.1. ICT Competencies and ICT Usage in Class

Engaging students in the learning process is one of the core points of classroom management [44]. There are several directions for improving ICT competence through the introduction of eye tracking research. First, some gaps or limitations may be noticed in the video recording process. For example, the expert teachers feel more comfortable and can in many cases immediately communicate with students. They are not stressed out when

pupils become too loud or silent, and they are free to walk around the classroom and help pupils individually. The general effectiveness of ICT use in school depends on the actual practical work of teachers and their ability to integrate ICT into the learning process [31]. At the same time, the management of an expert teacher's classroom differs from that of a novice teacher in the approaches to introducing ICT during on-call work. Novice teachers looked tense and stood in front of the classroom, closer to the computer. They claim that there are cables in the classroom and are afraid to get caught. Further, the provided eye tracking results provide comparative information for the teacher to examine behavior for inconsistencies and shortcomings related to the implementation of ICT in the classroom. It is important to note that eye tracking results provide a set of standardized data to enable such comparison in practice.

It is important to note that ICT motivates and engages students in the learning process [30]. The observation of the videos confirmed this, leading to the conclusion that ICT can be an aspect of the lesson that in some cases makes learning and teaching more attractive and engaging. However, the expert teachers in the experiment felt that ICT had little impact on pupils' classroom behavior. Comparative eye tracking feedback and analysis of video recordings reduced teachers' skepticism in this direction. The results also confirmed that the difference in teaching effectiveness depended on teachers' skills in using ICT. Some of the skepticism may be the result of a routine approach to the use of technology, so some improvements are needed in teaching approaches, providing teachers with additional motivation to use more advanced technology, as in the case of experiments with eye tracking equipment.

5.2. Student Centerd Education and Non-Verbal Communication

It may also be noted that eye contact is important for interaction with students and for overall classroom management [45]. In learning dialogue, teachers usually distribute their attention relatively unevenly among students. In high-quality instructional dialogue, more students receive visual attention than in medium-quality dialogue [46]. When teachers work with the whole class, they should behave with restraint and be attentive to the majority of students for better learning and student behavior, while at the same time teachers should give priority to students [27]. The results showed that novice teachers pay more attention to the screen and equipment than to the students. They are much more concerned about their interaction with ICT during the lesson, e.g., how not to forget what to say, how to operate the computer and multimedia.

Another important aspect of the student-centered approach is non-verbal communication, which is considered an important source of motivation and concentration in student learning, as well as a tool to attract and retain attention [47]. The results show that most teachers looked more and longer at a certain part of the class. They argue that this is the part of the class where students have learning or behavioral problems. However, focusing on problem areas in the class is a common behavior of teachers that has nothing to do with the subject. When explaining something, teachers should scan the whole class because eye and head movements increase pupils' attention span and the speed at which they follow the teacher. Eye tracking feedback provides a set of solutions and appropriate feedback to improve non-verbal communication style.

5.3. Self-Reflection and Class Work Improvements

All teachers have feedback on eye tracking records and this helps them to improve their behavior in the classroom when ETE is used. Both novice and expert teachers described what they can change in their lessons to improve ETE use and interaction with students. When analyzing notes from the expert teachers, novice teachers find some useful directions in using the teaching and learning equipment. Some expert teachers perceive useful aspects in novice teachers' notes. By analyzing their lesson recordings, teachers reflect over some possible improvements in classroom management. These were all examples of the

effectiveness of using eye tracking research methods to improve teaching style through self-reflection and interpersonal communication in the school environment.

5.4. Limitations and Future Research

The recording process itself and the process of wearing the glasses had an impact on the behavior of the teachers and students. They felt a little tense and unnatural, especially at the beginning of the experiment. Both novice and experienced teachers considered that most students were more taciturn and withdrawn, but after a few recorded lessons they overcame this situation. The expert teachers tried to make the students more comfortable by motivating them, asking additional questions or inviting them to present their class work. Some of the expert teachers were more active than usual due to some tension caused by the new experience, which made the students be silent and less active than usual. In general, teachers' and students' emotions affected the results of the experiment. In some cases, teachers seemed tense and students could not actively participate in the learning process as they would in a normal classroom setting. This limitation was overcome during the experiment when the experience of using the equipment came and the initial stress was relieved.

As an additional limitation, the relative assignment as "expert" or "novice" teacher should be mentioned. By "experts" we mean advanced users (regardless of teaching experience) of ICT and, accordingly, "novice" as low-competent users (in connection with the practical application of ICT).

Another limitation is the relatively wide range of language classes covered, including L1, L2, and L3 classes. This limitation is, however, mitigated by unifying the technologies used in all language classes in the selected secondary school settings.

The limitations described earlier provide *directions for future research* since, firstly, it is important to mitigate the impact of this problem on the overall experimental outcome and, secondly, to develop an understanding of how to avoid "fear of technology" [48] and general acceptance of technology, a common problem particularly evident in the issue of COVID-19 pandemic impact [49]. Another aspect that needs to be explored is the attitude towards participation in the educational experiment itself. By looking at the teacher as a tester, we move into a new dimension related to competence and attitudes towards scientific work as part of the professional development of the teacher. At the same time, explicit student involvement provides a practical example of a kind of citizen science [50], which is an important aspect for educating a whole and responsible person.

Author Contributions: Conceptualization, V.D. (Valentina Dagienė) and V.D. (Vladimiras Dolgopolovas); methodology, formal analysis, V.D. (Vladimiras Dolgopolovas) and E.J.; investigation, V.D. (Vladimiras Dolgopolovas) and E.J.; resources, E.J. and V.D. (Valentina Dagienė); writing—original draft preparation, E.J.; writing—review and editing, V.D. (Vladimiras Dolgopolovas) and V.D. (Valentina Dagienė); visualization, E.J.; supervision, V.D.; project administration, V.D.; funding acquisition, V.D. (Valentina Dagienė). All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study, as this study involves no more than minimal risk to subjects.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Original data available on request. They are not archived in any repository.

Acknowledgments: The eye tracking intervention was supported by Project "e-Teach": Improvement of teaching techniques by eye tracking in technology enhanced classrooms Erasmus Plus KA2 Strategic Partnerships for School Education—Development of Innovation—action n. 2017-1-TR01-KA201-046748.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Self-Reflection Interview Questions

Appendix A.1. Motivation

What do you think about using technological equipment and e-learning content in your lessons?

What technological equipment do you use differently from what we see in the video?

In what part of the course do you integrate this technological equipment?

Why do you use ICT in your class?

How often do you use ICT?

Appendix A.2. Recording

How well do these recorded lessons match your actual lecture sessions? Has the recording of lessons affected the course flow?

Difficulties in preparing for the recording?

Appendix A.3. Class

What are the dynamics of the classroom work (classroom management, student attention, course materials, etc.)?

What are barriers/challenges to using educational technology equipment and materials in the classroom?

Success in the use of ICT.

Some aspects of the teacher's personality.

Appendix A.4. Teacher's Lessons

Why do you choose these digital material and equipment to enhance your lessons?

Description of the lesson I.

What about eyes tracking?

Description of the lesson II.

Differences between two lessons.

Appendix A.5. Lessons of Colleagues

What technological equipment did s/he use differently than in your lessons? Are there any differences and similarities?

In which part of the course did s/he integrate this technological equipment? Why did s/he integrate it?

What have your colleagues done differently than you?

Do you think that your use of ICT in class will change after watching this video?

Appendix B. Equipment and Recordings

Records of each lesson have been compiled:

- One video from the teacher's point of view (POV) with the teacher's voice and teacher's gaze in the tracking data mapped on the video frames;
- Video recordings of the classroom (one view each from the front and back of the classroom) with audio recording from one microphone (used for manual synchronization with the teacher's POV recording);
- Automatic projection of the teacher's gaze at data from manually selected time intervals of gaze at manually selected screenshots from the lesson video footage (synchronized with the teacher's gaze and POV video footage, synchronized manually).

Teacher's POV video, their voice and their gaze data were captured by eye tracking glasses Tobii Pro Glasses 2 (100 Hz) with built-in camera and microphone at 100 Hz gaze data capture rate, video resolution of 1920 × 1080 pixels at 25 frames per second (compression AVC 4990 Kbps) and audio of 16-bit sample size and 24.0 KHz sampling rate (compression MP3 128 Kbps). The views of the classroom were captured by two IP cameras (Axis p1355 with resolution of 1920 × 1080 pixels at 25 frames per second

and AVC 1924 Kbps compression). Classroom sound was captured by a Sennheiser MKE 2 Gold microphone with Sennheiser K6 P microphone power unit at 16-bit sample size and 44.1 kHz sampling rate (compression AAC 158 Kbps).

The video signal of the two Axis p1355 IP cameras and audio from the Sennheiser microphone were synchronized and recorded using Noldus Media Recorder 4.0. Two Dell Precision m4800 laptops (Intel Core i7-4810MQ 2.8 Ghz, 8 GB RAM, 250 GB SSD) were used for the recordings. The first one was used for controlling eye tracking glasses via Tobii Glasses Controller software and analysis of gaze data via Tobii Pro Lab 1.86. The other laptop was used for recording classroom videos via Noldus Media Recorder 4.0. Before each recording, Tobii Pro Glasses 2 were calibrated using the single-point calibration option and following the standard procedure with the calibration card.

Appendix C. Data Analysis Methods

Recorded videos from the classroom and the teacher's POV were manually synchronized using Adobe Premiere CS6. After synchronization, 2–4 screenshots from the classroom videos were manually selected for automated gaze mapping. The first screenshot was taken at the start of the lesson, the second was taken at the end of the lesson and in several cases, additional screenshot were taken at several points when a student came in late for the class or students changed their locations in the classroom. The selected screenshots were imported into Tobii Pro Lab 1.86 for automated gaze mapping. Timestamps of these screenshots were used for dividing the recordings into time intervals from which the gaze data mapping algorithm (default settings for eye tracking glasses projects were selected) of Tobii Pro Lab 1.86 took the data and mapped it on the screenshots in the form of so-called 'heat maps'. These are a projection of teacher's gaze fixation points as opaque colored dots on the screenshot and their color represents absolute gaze duration (green—low duration, yellow—medium duration, red—long duration). When exporting heat maps, the setting of 10% transparency (or 90% opaqueness) was used to improve visibility of the classroom in general and individual students in particular.

The resulting heat maps were exported as two types of files: (a) screenshots with mapped gaze data, and (b) mapped gaze data with transparency layer instead of the screenshot. The latter type of file (with the transparency layer) was used as an overlay for classroom videos in the final merged video. Transitions between different time intervals used for analysis were smoothed by using video transition effect 'crossover dissolve' found in Adobe Premiere CS6. Final merged videos were used for interviews with teachers and for assessment by education experts. In total, 12 videos were used in the interviews and six videos were assessed by education experts.

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