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Effectiveness of generative learning strategies in independent study of english using mobile technologies

Eficacia de las estrategias de aprendizaje generativo en el estudio independiente del inglés utilizando tecnologías móviles

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Abstract

The aim of the research is to determine and evaluate the practical impact of the educational concept of generative learning in independent study of the English language with the development of the most appropriate and effective educational system. The following methods were used to achieve the aim of the research: EF SET testing, correlation analysis, statistical and mathematical forecast models. Empirical component of the research and the analytical interpretation of the results indicate a positive effect in the application of generative methods of learning English. It is quantified by an improved dynamics of learning English for students of the experimental group (relative to the indicators of the control group) — 2.915 times. Performance for the final test for the group which learned using typical methods was 3.06%. The relevant indicators for the group that received focal knowledge by generative learning methods were 8.92%. The results of the study indicate the practical impact of the concept of generative learning on the effectiveness of learning English, and the significant potential for other applications. It is advisable to conduct repeated empirical studies in other educational institutions and other educational subjects taking into account the established facts. The results of those studies will be the ground for developing a generalized educational standard, which will be proposed by the Ministry of Education and Culture of Ukraine for integration and implementation into approved teaching methods.

Key Words: Concept, system, generative learning, strategy, methods, efficiency.

Resumen

El objetivo de la investigación es determinar y evaluar el impacto práctico del concepto educativo de aprendizaje generativo en el estudio independiente del idioma inglés con el desarrollo del sistema educativo más adecuado y eficaz. Se utilizaron los siguientes métodos para lograr el objetivo de la investigación: pruebas EF SET, análisis de correlación, modelos estadísticos y matemáticos de pronóstico. El componente empírico de la investigación y la interpretación analítica de los resultados indican un efecto positivo en la aplicación de métodos generativos de aprendizaje del inglés. Se cuantifica por una dinámica mejorada de aprendizaje de inglés para los estudiantes del grupo experimental (en relación con los indicadores del grupo de control) — 2.915 veces. El rendimiento de la prueba final para el grupo que aprendió utilizando métodos típicos fue del 3,06 %. Los indicadores relevantes para el grupo que recibió conocimientos focales por métodos generativos de aprendizaje fueron 8,92%. Los resultados del estudio indican el impacto práctico del concepto de aprendizaje generativo en la efectividad del aprendizaje del inglés y el potencial significativo para otras aplicaciones. Es recomendable realizar estudios empíricos repetidos en otras instituciones educativas y otros temas educativos teniendo en cuenta los hechos establecidos. Los resultados de esos estudios serán la base para desarrollar un estándar educativo generalizado, que será propuesto por el Ministerio de Educación y Cultura de Ucrania para su integración e implementación en métodos de enseñanza aprobados.

Palabras clave: Concepto, sistema, aprendizaje generativo, estrategia, métodos, eficiencia.

1. Introduction

Relevance

According to the estimates by the *Statista Research Department* (2023), the English language occupied a leading position in the global social and information space in 2022. The reason is that about 1.5 billion people communicate in English as their mother tongue or as a second language. This is 36.4% more than Chinese (Mandarin) language (1.1 billion users), and 2.5 times more than Hindi (602.2 million users). The global spread of the English language is impressive: as Yadav (2023) noted, English has the third largest number of native speakers who use it in everyday life (373.0 million native speakers, after Chinese (Mandarin) – 930 million native speakers and Spanish languages - 475 million native speakers (Ethnologue, 2023a)). This is an extremely high indicator among the 7,151 languages that exist in the modern world (Ethnologue, 2023b). English has become the most widespread in atypical linguistic environments in such countries as India (265 million users), Pakistan (104 million users), Nigeria (60 million users) (Yadav, 2023; Ethnologue, 2023a) etc.

Such spread of the English language is the result of people's striving for the use of a universal means of communication. Only 23 languages among such a large number of existing languages (as mentioned above) are used by the majority of the world's population (Ethnologue, 2023b). Only 4% of communication takes place between native speakers, while 96% of communication takes place with the involvement of at least one non-native speaker (Yadav, 2023). Therefore, the English language is de facto a means of international communication, which is confirmed by the following facts:

- according to the monitoring group W3Techs (2023), the English-language sector of the Internet amounted to 57.7% in 2022, almost 11 times exceeding the closest competitor (5.3% - the Russian-language sector). This indicator maintains a stable median value at the level of 55% in the dynamics of the last decade;
- the majority of scientists, engineers and researchers use the English language: more than 50% of research, scientific and technical works are published in English (Shi-Xu & Pardo, 2018), more than 80% of academic journals are published in English only (Adroit Market Research, 2023);

- Gration (2023) notes that English has the status of the state language in 55 countries (28.5% of the total number). If we take into account the spread of the English language in business and everyday life in individual countries, the number of countries where English has a formal status will be 75 — 39% of all countries of the world. Moreover, there are currently local territories that give the English language official state status (Saba and Sint Eustatius (Netherlands), San Andres and Providencia (Colombia), Hong Kong (China), etc.).

According to estimates by Mykhalevych (2021), by 2050, English will remain the third in terms of the number of native speakers (after Chinese (Mandarin) and Spanish). It will show the largest growth of 44.7%, when the number of people who naturally use increases to 534, 3 million users. However, as *ISA* (2023) noted, the share of the English-language sector of the world economic sphere will continue to occupy a leading position, and will increase to 34% of the world volume by 2050 (3 times greater influence on the world economy than that of the nearest competitor — the Mandarin (Chinese) language (11%)). This will allow the English language to occupy a leading position and increase the number of users to 1.65 - 2.0 million people (Gration, 2023). So, we state that the English language is a universally recognized communicative tool for access to the leading international multi-area platforms. Therefore, research and development of effective methods of learning this language is not only relevant, but also urgent.

Unexplored Issues

Despite the numerous methods developed for learning English, there is currently no generalized teaching method in the world community that would be considered the most effective and would give fast results. Gration (2023) notes that the English language is compulsory for learning under the approved school programmes in 138 countries. Teaching of the studied language begins for children on average from 6 to 12 years old. In addition to the spread of mandatory English language learning for children, there is also a growing interest in learning this communicative tool among the adult population. It provides wider opportunities, which is confirmed by a significant number of requests on Internet search engines regarding English language learning, while users from the United Arab Emirates, Malaysia, Sweden, etc. show the greatest interest (Gration, 2023).

The scale of the influence of the English language on the educational sector can be estimated by several important factors:

- According to estimates by HolonIQ (2023), the international education is confirmed by certificates of the appropriate level of accreditation. These certificates are provided upon defence of attestation work in English. The current volume of the specified educational services is estimated at 10 - 20 million students annually, By 2030, this indicator will increase to 1 billion university graduates, which has direct economic consequences. The reason is that the field of international education currently attracts investment of $196 billion, and will amount to $433 billion by 2030 (with the projected average annual growth rate of 7.4%). So, it is necessary to have an appropriate level of English language proficiency in order to obtain a professional qualification of an internationally recognized accreditation level;
- Adroit Market Research (2023) estimates the current volume of investment in learning of the English language at $12 billion, and predict a further increase of the studied educational sector to $69.62 billion in 2029 (with a projected average annual growth rate of 9.5%). The researchers note the following practical methods most often used to learn English: classic method based on thorough manuals, face-to-face course in the form of group training and online learning. According to Adroit Market Research (2023), the development of digital means of learning English language is the key economic driver of the development of the field of English language learning. However, one of the restraining factors mentioned in this marketing research is the lack of a unitary approach and effective methods of acquiring relevant skills in mastering the English language;

- According to the analysis of the results of the Verified Market Research (2023a), we come to the conclusion that the financial consequences of the growing the influence of the English language on educational and professional activities will be manifested in the increasing investment in English language knowledge tests. They are used to confirm one's qualification and accreditation level. The investment increased from the current $1.9 billion to $6.2 billion by 2030 (with the projected average annual growth rate of 14.76%. Verified Market Research (VMR, 2023a) distinguishes *The English Language Proficiency Test (ELPT)* and *The Test of English as a Foreign Language (TOEFL)* among the test leaders. But the development of digital tools creates qualitatively new approaches and changes the basic principles of the field of accreditation. This is a direct consequence of the increasing number of specialized network educational platforms (VMR, 2023b) and the general digitalization of English language learning. Investment in the digital services for learning English will increase from the current $4.13 billion to $12.82 billion in 2028 (with a projected average annual growth rate of 15.32%) (VMR, 2023c).

So, we state that currently the field of learning English as a tool for access to multi-sphere international platforms attracts investment in educational and accreditation processes. The development of digital means of the Internet was a significant impetus for that. It offers a wide range of variations of educational programmes and methods, and requires careful research and establishment of the most effective and appropriate ones for implementation as a generalized effective methodology.

Aim

The aim of the study is to empirically test the hypothesis about the potential effectiveness of the application of generative teaching methods in increasing the level of English language proficiency with the appropriate use of accredited testing and verification methods.

Objectives/Questions

The aim involves fulfilment of the following research objectives:

- make a sample among the focus group of students by means of preliminary pre-experimental testing for the level of English language proficiency;
- form two groups (experimental and control) with an appropriate number of participants in the educational process based on the median selection principles to ensure a wider sample and establish a confidence range of qualitative and evaluation indicators);
- develop the organizational and technological sequence of conducting an experiment with the development of an appropriate scheme for learning English using generative learning strategies for students of the experimental group;
- based on the results of a repeated post-experimental study, draw analytical conclusions on the influence of generative learning strategies on the assimilation of educational material in English language courses;
- based on the results of empirical research and analytical summarization of the data of the scientometric framework, develop recommendations for the implementation of generative learning as an effective and efficient method of teaching English, also for students of Ukrainian universities.

2. Literature review

Multilocal information search helps to select relevant academic publications and specialized studies on the application of generative methods and strategies in the educational field.

Hulukati et al., (2023) proved the effectiveness of the generative learning model (*The Generative Learning Model*) when integrating this method into an educational programme for studying mathematics, which was empirically confirmed by the results of a random sample of 171 surveyed students. It was also established that the generative learning model correlates with the improvement of mathematical skills and does not correlate with the previous experience of the respondents in acquiring mathematical knowledge. Therefore, the application of generative learning is positively evaluated for implementation in training programmes for target groups with different performance levels in obtaining mathematical education.

Roelle, Froese et al., (2022) established an appropriate sequence of introducing the stages of generative learning, which improves the memorization of the material and reduces cognitive load, on the basis of empirical studies conducted for 158 university students. The results of the study gave grounds to advise the introduction of the *Retrieval-Before-Generation* phase, which has an impact on the effectiveness of generative learning.

Another study by Roelle, Schweppe et al., (2022) confirms the effectiveness of the integrated application of generative learning and search practice in educational activities. It follows from the conclusion that, instead of consolidating mental representations, generative activity should have the construction of coherent mental representations as its main function. So, it was established that engaging students in the practice of searching for learned information contributes to the consolidation of students' mental representations and, therefore, long-term memorization.

Buchner (2022) studies the impact of generative learning on the motivational and emotional factors of the perception of new technological means — *the augmented reality* — in the education of primary schoolers. The empirical research for 56 schoolers established the fact of increased scepticism towards the use of modern mobile tools in the educational process and augmented reality technologies by representatives of the experimental group. For this purpose, a correlative comparison of experimental (application of generative teaching methods, namely, self-explanation and self-testing) and AR mobile educational tools) and the control group (application of AR technologies only) was used. However, the general perception of the use of AR technologies in education was perceived positively by both representatives of the control group and pupils with integration of generative strategies into the educational process.

Mohammed (2022) experimentally proved the correlative effect of generative teaching methods on the expressive performance of fourth-grade students in natural sciences on the basis of control (32 students) and experimental (33 students) groups. According to the results of the research, it was established that there is an educational need for fourth-grade students to use modern teaching methods. It was also found that the generative learning strategy works to develop higher mental levels of thinking and the right way of thinking.

Anshari and Akmam (2022) emphasizes the need for the continuous development of the competences of the teaching staff of the general education system with the adaptation of relevant qualifications to the modern requirements for the organization of the learning process with the involvement of modern digital tools and the Internet based on generative educational strategies. In particular, the study demonstrates the positive impact of training of the teaching staff on the possibility of involving generative teaching methods in the educational process using digital means and multimedia synchronous presentation content. This contributes to increasing the effectiveness of the generative education system.

In view of the focus of this study, Bardone et al., (2022) objectively indicated the difficulties of implementing the educational process of learning English for the relevant teaching staff caused by the impact of the global pandemic restrictions. Three groups of high school students were empirically studied in interaction with an English teacher in the conditions of limited physical attendance of educational institutions and intensification of the online educational process. The results of the study revealed the problem of uncertain

expectations for the effectiveness of both the teacher and the students — the uncertainty led to the formation of *"genuine creative"* tension. So, the use of generative learning methods, in particular, self-education, allowed two parties of the learning process to focus on the immediate educational task, reducing the focus on expectations of results and other uncertainties.

Osman and Shahrani (2022) conducted an experiment with 48 students divided into 2 groups: experimental and control. He empirically proved the effectiveness of the generative model of learning synonyms and antonyms in the English school course. The results indicate a statistically significant difference between the average scores of members of the experimental and control groups for the post-test in the levels of memorization, understanding and application in favour of the experimental group. The latter was trained according to the generative model throughout the experiment.

Wang (2022) proposed a new method of summative assessment of the level of English based on the use of modern digital solutions and cloud services. This, in turn, involves the use of generative learning of the English language. It was proved that a diversified assessment process can not only ensure that students complete their learning assignments efficiently and quickly. It can ensure that students are evaluated objectively and rightly compared to the typical methods of final assessment of the level of knowledge at the end of an English language course.

Seo (2022) empirically proved the impact of generative learning systems in combination with the appropriate design of multimedia content involved in the educational process on the quality of learning English. The results were obtained from the surveys of 232 college students who participated in an online English language training. It is proposed to create the educational content with the possibility of its generative regulation for students studying according to the generative strategy for learning English.

Oktaviani et al., (2021) proves the effectiveness of applying generative methods of teaching English for students of a special educational institution using modern digital tools and methods. This illustrates the potential possibility of combining a generative strategy for learning English with modern systems of multimedia presentation of educational material.

Hao and Othman (2021) proves the effectiveness of automating the *Second Language Acquisition (SLA*) by integrating generative learning models updated through modern digital means that form adaptive and appropriate multimedia educational content.

Wang (2021) proves the effectiveness of using a generative learning model in online English learning. In this model, a student is not a passive recipient, but an active participant in the learning process, who builds a meaningful understanding of information in the environment. That is, the generative learning model in the concept of "attention, motivation, experience of prior knowledge and generation", and also the concept of "attention" enable obtaining comparable results in learning English.

The following terminological and taxonomic basis was established based on the results of the multilocal information search.

A generative learning strategy is a system of learning new information arrays by identifying important aspects, vectors and focuses, recombining new data and their correlative integration into an already existing system of personal knowledge. In other words, new knowledge is assimilated with the help of pre-arranged information that make up the knowledge base of each individual student involved in the educational process.

There are eight generative strategies, which have separate limitations and features of application, which include: summarizing, mapping, drawing, imagining, self-testing, self-explaining, teaching, enacting – Table 1.

Table 1.
Characteristics of typical generative learning strategies

The name of the generative strategy	Characteristics and features of application	Application limitations
1	2	3
Summarizing	A training system that involves the application of the technique of finding the main aspects of the studied data set, logical-structural recombination of information flows and correlative matching of new information with already arranged knowledge	It is appropriate to use it for the study of spatially arranged and relatively uncomplicated information arrays. A more effective scheme of implementation is learning with an integrated practice model with feedback
Mapping	A learning system that involves mastering new information arrays by interpreting the main aspects in the form of conceptual maps, knowledge maps, graphic organizers, etc. The identified main aspects of the studied information flows, which are subject to the mapping interpretation procedure, must be consistent with the previously acquired knowledge	Information mapping is a rather time-consuming process and requires significant preliminary preparation. Therefore, this technique must be used with appropriate motivation to study new information in this way
Drawing	The information to be learnt are interpreted graphically with the creation of appropriate graphic images that reflect the main aspects of the studied information. The identified focuses and aspects of the studied information flows should be consistent with the previously arranged knowledge, taking into account the context of the graphic display of the recombined information.	The effectiveness of this technique depends on the clarity of the idea of the studied information and successful graphic interpretation. The appropriate organization of this strategy involves a preparatory period, when students are provided with detailed instructions, content that can be partially used, and relevant motivational trainings that improve the quality and adaptability of this educational technique
Imagining	New information is learnt through the mediation of adaptive imagery, where the mental images created by learners represent the focal aspects of new information streams that are consistent with previously acquired knowledge	It is appropriate to apply to students who have a significant arranged knowledge system. Therefore, it is necessary to carry out pre-testing in order to determine the initial level of arranged knowledge of the target group for the introduction of this method,
Self-testing	A search-based learning system, which provides for the determination of the most relevant information, which is further systematized and coordinated with previously acquired knowledge. Search activity under this learning strategy simulates the final test	Self-testing is advisable before implementation after the first familiarization with the studied information, and requires frequent and repeated application
Self-explaining	A system of education, in which students carry out its systematization and coordination with	The methodology cannot be applied all the time and requires preliminary

	previously acquired knowledge, while applying their own methods of understanding and recombination of the studied information flows from the beginning of the process of assimilation of new information	preparation with the definition of corrective and reference points in the development and arrangement of new information
Teaching	Under this strategy, students are involved as teaching staff to teach other students. In this case, the training is focused on independent aspecting and structuring of new information by students- "teachers", and their recombination and coordination with previously acquired knowledge for students- "students"	The method is time-consuming, as it requires preparatory actions and control on the part of the teaching staff in order to prevent misinterpretation of the educational material
Enacting	A learning system that involves the assimilation of new educational material using active physical actions (manipulation of studied objects, use of informative and communicative gestures, etc.).	Active interpretations must be consistent with previously acquired knowledge. The application of the methodology requires prior instruction regarding the recognized spectrum of possible actions and further control by the teaching staff regarding the correctness of the activity when learning new educational material.

According to the information in Table 1, we state a generalized terminological-taxometric basis: generative learning strategies are educational systems that provide for the active, personalized participation of students in the educational process using established methods. The prerequisite here is the further coordination of new information arrays with previously acquired knowledge.

The results of the literature review give grounds to conclude that the generative learning strategy is quite effective in learning English, which, in combination with modern digital tools and appropriately organized multimedia content, will allow students to significantly improve their English language proficiency.

3. Methods

Research design

The research involved a search from the selected research vector in several logical stages (Figure 1):

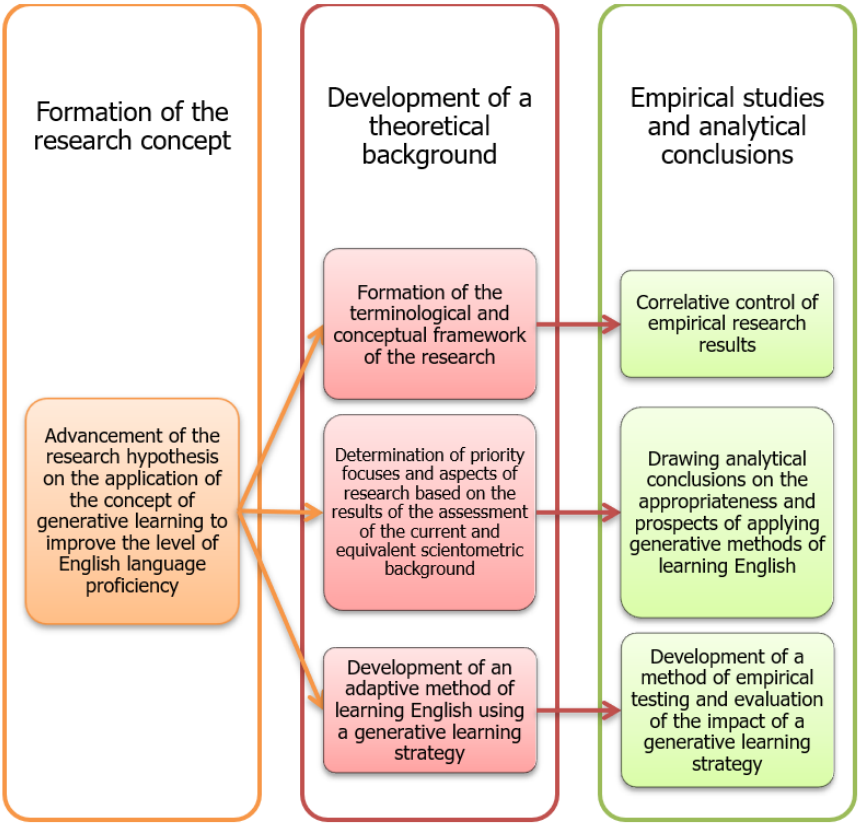

Figure 1. Algorithmized sequence of research

The algorithmic sequence of research is as follows:

- development of a generative method of learning English for students using individual forms of education with the use of appropriate digital means, the Internet, and specialized multimedia content;
- empirical studies: testing of the level of English language proficiency among university students, which was conducted before and after the experimental stage of the study. The students were divided into two target groups in order to assess the impact of the developed methodology of the generative strategy of learning English. The control group consisted of 76 people, who were trained using a common method. An experimental group consisted of 76 people, who studied using the generative educational model;
- analytical research: analysis of the results of the empirical stage of the research, followed by drawing conclusions and making propositions on the potential integration of generative methods of earning English for university students.

The structured stages of the research (Figure 1) will ensure the purity, directness and control of the obtained research data.

Sampling

The sample was conducted among the students of T.H. Shevchenko National University "Chernihiv Colehium" at the Department of Languages and Methods of Their Teaching, the students of Academy of the State Penitentiary Service at the Department of Foreign Languages, the students of Borys Grinchenko

Kyiv University at the Department of Germanic Philology of the Faculty of Romance and Germanic Philology, the students of Chernihiv Polytechnic National University at the Foreign Philology Department, and the students of Alfred Nobel University at the European and Oriental Languages and Translation Department. The first-year students were selected. The aim was to create an indirect research background based on the results of a previous independent assessment according to the Common European Framework of Reference for Languages (CEFR) (Council of Europe, 2023) using the corresponding EF SET (2023) certified platform. Students with an educational level of English proficiency A2 Elementary according to CEFR (Council of Europe, 2023), determined on the basis of the EF SET (2023) in the range of 31-40 points, were selected for the target groups. The corresponding testing method is described in the publications of De Angelis (2023), Savski (2023), Shatz et al., (2023) and others.

The students who passed the criterion selection (based on the results of the *EF SET* (2023) pre-test) in order to obtain an indirect assessment of the influence of generative learning models on the level of English language proficiency with the achievement of an acceptable frequency of empirical searches, were divided into two groups:

- a control group consisting of 76 people, who studied according to the educational programme approved by the university and makes the initial reference values for correlative and comparative analysis;
- an experimental group consisting of 76 people, who studied using the methods of generative learning of the English language according to an individual schedule using mobile technologies and cloud services.

The proposed English course is built in the form of a mobile application that regularly provides information to each student of the experimental group in compliance with the approved training programme. The information is provided according to an individual schedule for the perception of new material with the integration of relevant methodological concepts of generative learning — summarizing, self-testing, self-explaining. These strategies were described above in Table 1).

According to the indicator of qualification correspondence to the students' level, the following modern software tools that allow learning English using generative methods are distinguished – Table 2.

Table 2.
A selection of software and digital tools that can be used in learning English using generative strategies

Application name	Brief description	Link
1	2	3
Rosetta Stone	An application (and online platform) that uses a generative approach to learning English using images, sounds and texts to enhance learning	*rosettastone.com*
English Central	An application (and online platform) that offers students video lessons, tests and exercises for grammar, vocabulary and pronunciation according to the scheme of generative learning	*englishcentral.com*
Duolingo	An application (and online platform) that uses a generative approach to learning English. It offers users exercises to build phrases and sentences with basic words and phrases	*duolingo.com*
Memrise	An application (and online platform) that uses a generative approach to learn new words and phrases in English using pictures, sounds and texts	*memrise.com*
Babbel	An application (and online platform) that uses a generative strategy for learning English. *Babbel* offers users a series of exercises and games to learn new words and grammar	*babbel.com*

Among the considered software and digital tools (Table 2), *English Central* is the most adequate to the set goal of generative learning of the English language. The control of the educational process according to the relevant indicators of the dynamics of knowledge of the English language provided by using the selected software and digital tool was carried out by the teaching staff involved in the experiment. The software and digital tools were adapted accordingly: a separate system of accounts with data transfer to one server was created.

The experiment, which was conducted during one academic semester, was followed by re-testing. All 152 participants with a mark of the control or experimental group were tested at the EF SET (2023) service. Based on the re-testing results, an analytical conclusion was made regarding the appropriateness of implementing generative methods in learning foreign languages.

4. Methods

The following methods were used in this study:

- development of a criteria-based model for the selection of potential participants in empirical tests of generative strategies for learning English;
- search of the target audience according to the criteria-based model with the formation of a wide sample among the students of a particular specialization according to the initial pre-experimental EF SET testing;
- selection of the median group of students based on the results of EF SET (2023) testing: the focus audience should consist of students whose English proficiency level is not lower than A2 Elementary according to CEFR (Council of Europe, 2023) (Table 3);
- ensuring the purity of the experiment by dividing the students who entered the experimental audience into two groups: the control group, for which the educational process was carried out in a typical approved way, and the experimental group, for which it was proposed to learn English using generative strategies;
- an empirical study of the impact of generative strategies for learning English through a correlative comparison of the initial and final testing of target groups of students according to CEFR (Council of Europe, 2023) using the EF SET (2023) service. The obtained results are compared with other recognized grading scales of English language proficiency: TOEFL iBT (2023), IELTS, TOEIC (R&L) Total Score (2023), Cambridge English Scale (2023), and Global Scale of English (2023) – Table 3;
- the results of repeated testing using EF SET (2023) are subject to statistical analysis with the identification of logical dependencies and an analytical conclusion on the potential integration of the generative learning method into educational programmes of higher educational institutions.

Table 3.
Relevance of the evaluation method

CEFR (Council of Europe, 2023)	EF SET (2023)	TOEFL iBT (2023)	IELTS (2023)	TOEIC (R&L) Total Score (2023)	Cambridge English Scale (2023)	Global Scale of English (2023)
< A1	1 - 10	n/a	n/a	n/a	80 - 99	n/a
A1 Beginner	11 - 30	n/a	n/a	120 - 220	100 - 119	22 - 29
A2 Elementary	31 - 40	n/a	n/a	225 - 545	120 - 139	30 - 42
B1 Intermediate	41 - 50	42 - 71	4.0 - 5.0	550 - 780	140 - 159	43 - 58
B2 Upper Intermediate	51 - 60	72 - 94	5.5 - 6.0	785 - 940	160 - 179	59 - 75
C1 Advanced	61 - 70	95 - 120	6.5 - 7.5	945 - 990	180 - 199	76 - 84
C2 Proficient	71 - 100	n/a	8.0 - 9.0	n/a	200 - 230	85 - 90

Source: EF SET (2023)

The main goal of the experimental course is the active participation of students in the coordination of new information with already existing and personalized knowledge experience.

Control of the process was carried out on the server of the experimental mobile application based on the relevant statistics regarding the passage of control points of individual training schedules.

The validity of the advanced hypothesis on the possibility and effectiveness of applying generative methods for learning English is finally confirmed by the results of empirical research.

So, an appropriate methodological framework was formed for conducting a study with the aim of refuting or confirming the hypothesis that generative learning strategies with the involvement of modern digital tools and appropriate multimedia content will be effective in obtaining appropriate levels in the English language knowledge.

5. Results

The criteria-based model for the selection of potential candidates for participation in the experiment to establish the influence of generative methods on the effectiveness of learning English course material is based on obtaining the median value of the qualification level according to the CEFR scale (Table 3) – Figure 2.

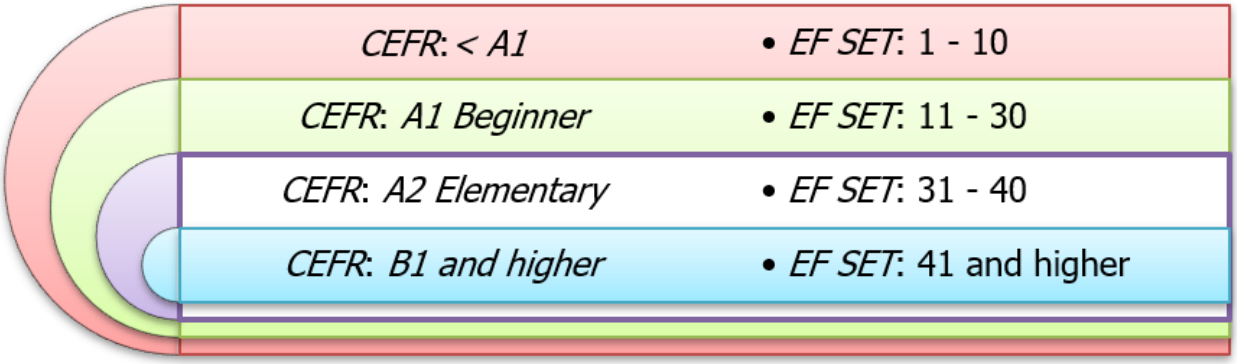

Figure 2. Criteria-based model for the selection of potential candidates for participation in the experiment on studying the influence of generative learning methods on the improvement of English language skills: the size of the sectors is equivalent to the expected number of students with the appropriate level of English; the focus audience that falls under the selection criteria of A2 Elementary is indicated by an element that is discoloured relative to the others.

The results of preliminary testing made it possible to establish the median value of the selection criterion for admission to participation in the experiment according to the criteria-based model (Figure 2). Pre-experimental *EF SET* testing conducted for 317 students of the selected specialization – Figure 3.

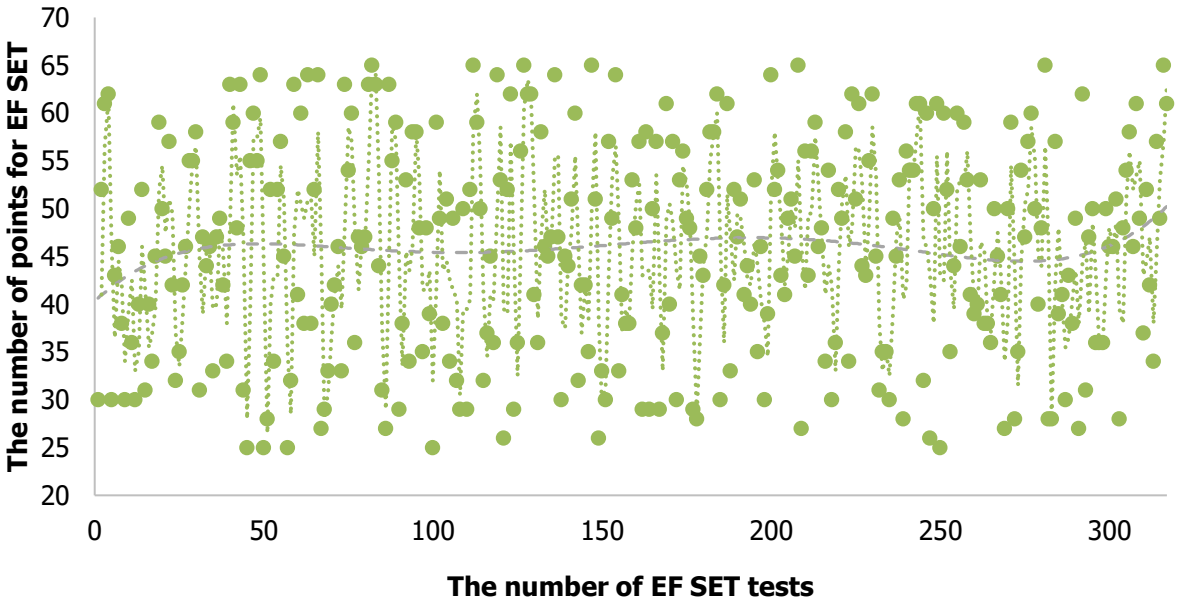

Figure 3. Results of *EF SET* testing of the general selection group.

The expected discretization of the general flow of students by the qualification level of English language proficiency (according to the criteria-based model - Figure 2) correlates with the results of the previous *EF SET* testing (Figure 3).

The test results (Figure 3) indicate a fairly wide range of the levels of English proficiency among the students of the focus group. It was necessary to apply polynomial averaging (with degree of 5) – Formula 1 to obtain the overall average value:

$$y = 2 \times 10^{-10}x^5 - 2 \times 10^{-7}x^4 + 5 \times 10^{-5}x^3 - 0.0064x^2 + 0.331x + 40.31;$$
$$R^2 = 0.0106. \quad (1)$$

The use of a fifth-degree polynomial to approximate the empirical data (Figure 3) was appropriate because of the tolerance of noise or random deviations in the experimental data, which complicate their interpretation and analysis. This method improves forecasting accuracy, reduce data analysis errors, and increase the level of reliability of results. This statistical and mathematical method makes it possible to identify trends and data cyclicality and reduce noise. This enables us to better understand and predict the behaviour of the system under analysis. The use of complex fifth-degree polynomials indicates a fairly wide spread of the obtained results. This requires sufficiently strict filtering methods to find median values and generalizing dependencies formula (1), which will later be able to provide predictive data for similar studied arrays.

S limit number of points— 31 – 40 (Figure 2) — was set in order to achieve the purity of the experiment and the harmonization of the input group. This corresponds to *A2 Elementary* level of English language proficiency according to *CEFR* (Table 3). As a result, 152 students were selected - Figure 4.

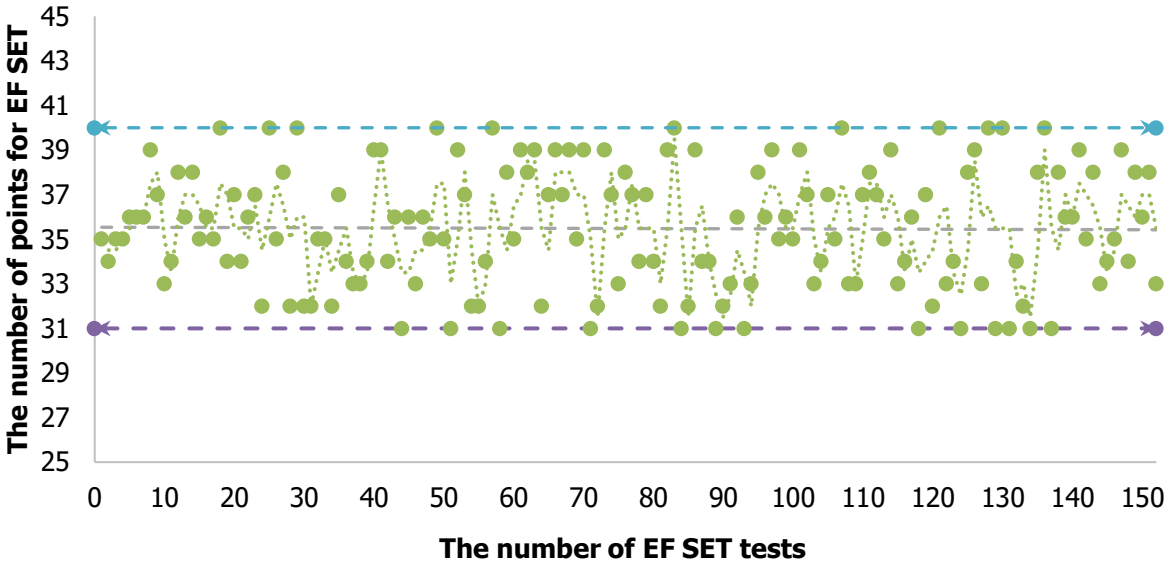

Figure 4. Limit-harmonized results of EF SET testing of selected students

In this case, linear extrapolation was used to obtain the average value (with an average value of 35.480 points) — Formula 2:

$$y = -0.0008x + 35.538;\ R^2 = 0{,}0001. \quad (2)$$

The application of linear extrapolation to establish the median value of the *EF SET* score (Figure 4) confirms the correct application of the criteria-based sampling model among the focus group of students (Figure 2). The formation of the confidence range separated within the *CEFR A2 Elementary* qualification level (Figure 4) proves the purity of the experiment and the absence of statistical noise and random coincidences. It was observed when selecting potential candidates for participation in the experiment, where a more complicated method of polynomial extrapolation with a high-level polynomial (5) was applied (Figure 3).

In other words, the use of the linear extrapolation method for filtering the obtained data set proves the relative homogeneity and averaging of the test results within the score range determined by the criteria-based model. This gives grounds to assert that the students involved in the experiment have equal opportunities to learn English and raise their *CEFR* qualification level.

The formation of the control and experimental groups was followed by the application of adapted generative methods for learning English, which were described in detail in the methodological section of this study.

Quality control and the course of the experimental research was organized with the help of software, digital tools and cloud technologies, which are described in detail in the methodological section of the research.

There were certain expectations from the experiment conducted to establish the impact of generative learning strategies on the effectiveness of assimilation of educational materials for learning English according to the criteria-based model (Figure 2). A slight increase in the qualification level of English language proficiency was expected for the students of the experimental group with a simultaneous increase in this indicator for both groups (including control group). The expectations were formed in accordance with the practical results of the experience of teaching English according to the typical approved programmes and methods. The results of the introduction of generative learning methods established on

the basis of the results of related studies of the selected research vector were also taken into account. A detailed description of each of the selected study is given in the Literature Review section of this study.

According to the general concept of the study, the impact of generative methods and learning strategies (Table 1) in learning English was evaluated according to similar indicators of the criteria-based model (Figure 2) — the number of points on the *EF SET* online service under the *CEFR* methodology.

A repeated EF SET test was conducted at the end of the experiment. It was established based on the results of repeated test that the students of the control group showed an improvement in the initial level of English language proficiency by 3.06% – Figure 5.

The data filtering method — linear extrapolation Formula 3 was used to establish the median value of the score for the post-experimental testing of students of the control group:

$$y = -0.0079x + 36.989;\ R^2 = 0.003. \quad (3)$$

In this case, data filtering by linear extrapolation also certifies the appropriate homogeneity and integrity of the group of selected candidates for participation in the experiment.

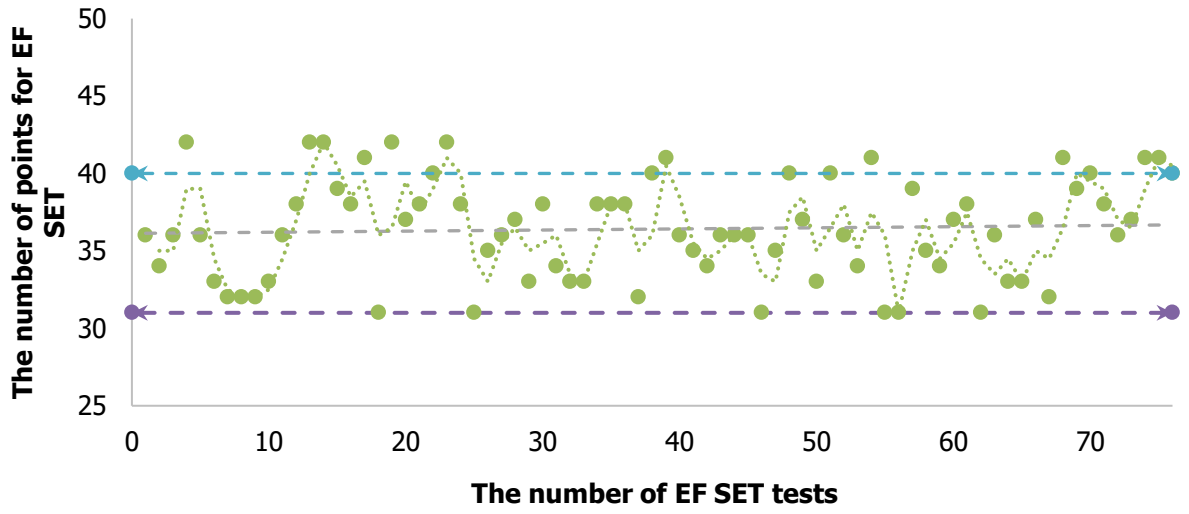

Figure 5. Results of post-experimental EF SET testing of control group students: improvement in English language proficiency – 3.06%

The data of repeated EF SET testing (Figure 5) were analysed. We observe that only a small number of students of the control group, who studied English according to the typical approved programmes and methods crossed the threshold of the range of EF SET scores corresponding to the CEFR A2 Elementary level and have progressed in learning a foreign language to the CEFR B1 Intermediate level (Table 3).

A similar procedure was carried out for the students of the experimental group, where the generative learning strategies and methods were applied during the empirical study. They are described in detail in the methodological section.

Repeated EF SET testing for students of the experimental group made showed an improvement in the level of English language proficiency by 8.92% more compared to the first testing – Figure 6.

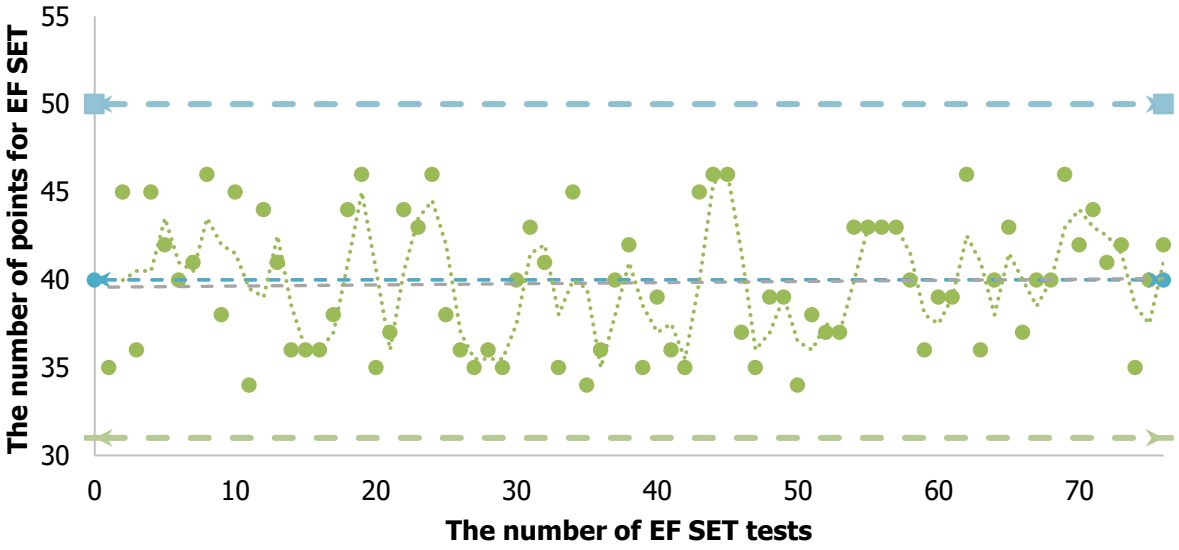

Figure 6. The results of the post-experimental EF SET testing of students of the experimental group: improvement in the level of English language proficiency – 8.92%

In this case, the homogeneity of the formed group is also confirmed by the application of filtering by the method of linear extrapolation – Formula 4:

$$y = 0.0065x + 39.578;\ R^2 = 0.0014. \quad (4)$$

The obtained results of the *EF SET* testing of students of the experimental group are significantly better than the results of students of the control group. This gives grounds to transfer a part of the students who have passed the experimental course training on generative learning of the English language to the *B1 Intermediate* level according to the *CEFR* methodology (Table 3).

It is worth noting that most of the students of the experimental group, when taking the repeated test of English language knowledge on the *EF SET* online resource, crossed the limit value of the range of the *EF SET* score of *CEFR A2 Elementary.* This enabled to expand the performance in the transitional position between two classes of the standardized *CEFR* score (Figure 6).

During the empirical testing of the hypothesis about generative strategies for learning English, the students of the experimental group provided information about the course and dynamics of the educational process of learning new material in English using personal digital tools and cloud services. The following aspects are systematized among the features of the course of the educational process:

- increased motivation, which students associate with the use of new learning approaches;
- the possibility of using an individual calendar plan, which enables students to determine the study periods for learning English at their own discretion, to be freer within the chosen period of the experiment, and to reduce anxiety about the inevitability of deadlines;
- increased interest, which is associated with the use of atypical and creative content for the organization of generative learning of English adapted to modern ideas about the interactivity of the educational process;

- regulation of the educational load, according to which students individually determine the difficulty of each session of learning English and can vary the intensity of increasing the difficulty of the assignments of each subsequent educational session.

The distribution of aspects of the course of experimental learning English according to the generative strategy has a corresponding variance of student impressions – Figure 7.

In contrast, the students of the control group note the following aspects of the typical methods of presenting educational material under the approved programmes and teaching methods:

- decreased motivation, which students associate with the low creativity and uniqueness of English language educational materials delivered in accordance with approved and established teaching methods;
- decreased interest that students associate with the possibility of providing course materials on the English language in open access, that is, students consider it inappropriate to attend educational sessions organized in the usual way;
- lack of regulation of the educational load and an individual approach to learning English, which students associate with the use of unitary and equalizing methods of providing educational material, which does not involve unevenness in teaching and must fully comply with the approved programmes and calendar plans
- anxiety about the possible onset of a state of unpreparedness for the knowledge test during the educational course, which students associate with the inevitability of knowledge tests that do not take into account the peculiarities of the individual perception of educational information for each participant in the educational process.

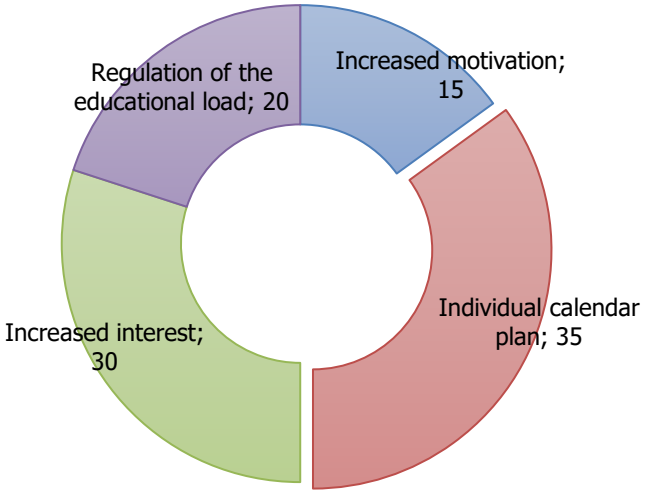

Figure 7. Variance of the impressions of students of the experimental group who studied English using generative learning methods

The distribution of aspects of the typical English language course has a corresponding variance of student impressions — Figure 8.

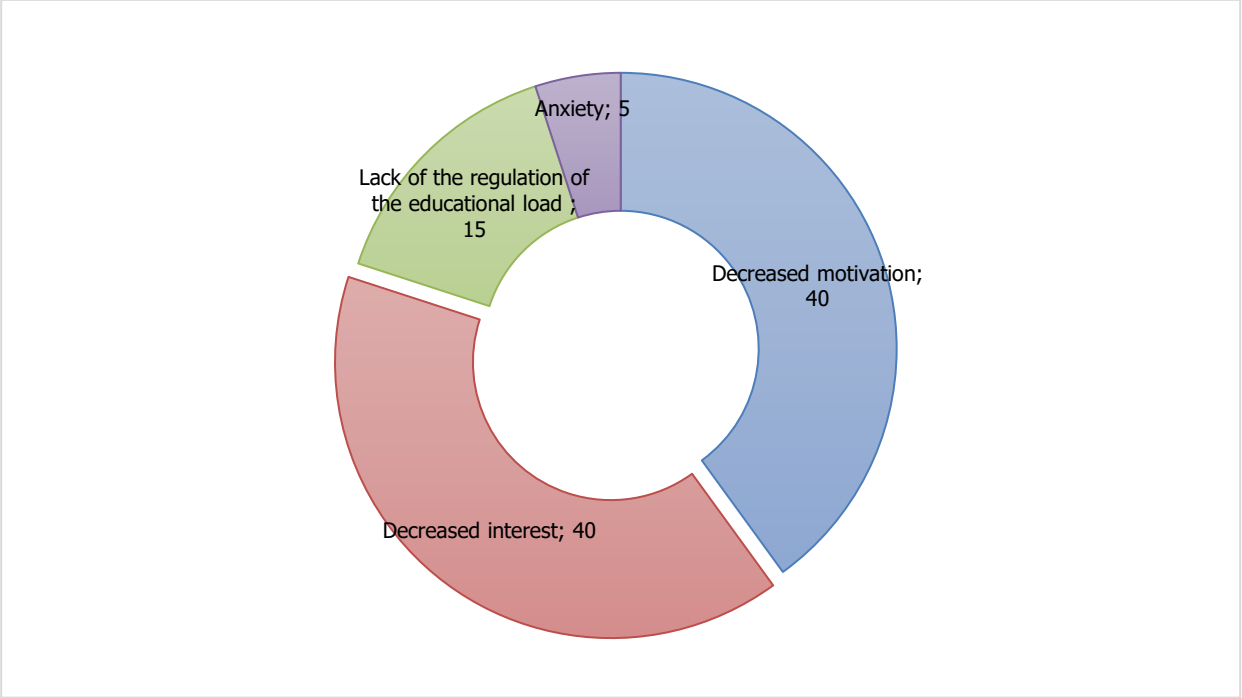

Figure 8. Variance of impressions of students of the control group who studied English using common learning methods.

According to the results of a cross-sectional and systematic survey, the main advantages of using generative methods in learning English for university students were established:

1. Increasing motivation to learn the language: generative learning methods can stimulate students to actively participate in the learning process, as they provide the opportunity to create their own text materials and use their own ideas to build conversational situations. This can help increase students' motivation to learn the language, and stimulate their interest in learning.
2. Active participation in the learning process: generative learning methods involve the active participation of students in the learning process, which enables them to be actively involved in language learning. Students can interact with each other, share ideas and answer questions, thereby developing their speaking skills.
3. Enriching vocabulary: generative learning methods enable students to actively use learned words and expressions in conversational situations. This can help to enrich vocabulary and improve the skills of using words and expressions in the right contexts.
4. Development of monologic and dialogic speaking skills: generative learning methods can contribute to the development of students' monologic and dialogic speaking skills. Students can have conversations on topics that interest them and create their own written materials, which provides an opportunity to develop self-expression and self-improvement skills.

Besides, generative learning methods also improve students' communication skills as they learn to create their own sentences and expressions in English. It helps students to be more confident in spoken language and communicate more productively with foreigners.

The results of the study prove the advanced hypothesis about the impact of generative methods and learning strategies on the effectiveness of learning English, which in turn requires a wider discussion and analysis.

6. Discussion

The results of the study confirm the advanced hypothesis about the potential possibility of improving the effectiveness of English language learning through generative learning methods using modern digital tools. Students of the experimental group showed a better level of English language proficiency for the repeated post-experimental EF SET testing compared to the results of students of the control group (with positive learning dynamics for both groups).

The resulting analytical conclusions correlate with the research results described in the publications of Osman and Shahrani (2022), Seo (2022), Oktaviani et al., (2021), Hao and Othman (2021) and Wang (2021). They are reported in detail in the Literature Review section of this study.

At the same time, there was no difficulty during the experiment regarding the uncertainty of the educational goals described in the publication of Bardone et al., (2022) in independent control. The reason is that personal data from the mobile (or online) platforms of the students of the experimental group with the required frequency, and at the controller's request, were sent to the online server. They were further analysed and adjusted, both individually and as a group, through the appropriate educational influence on the educational process according to the individual-general schedule.

The certified accreditation web resource *EF SET* (2023) was used to test and assess the level of English language proficiency before and after the experiment. It complies with the internationally recognized *CEFR* method (Council of Europe, 2023). Therefore, in this study there is no assessment problem described by Wang (2022). Moreover, the use of the specified accreditation web platform made it possible not only to perform testing and evaluation of the impact of generative learning models on the assimilation of English course materials. It also enabled forming a target group of students (experimental sample) with averaged *EF SET* scores. This method of selecting students ensured the indirect purity of the experiment, which was not observed in other studies. There researchers worked mainly with students who actually studied at a certain educational institution, or were selected randomly. The latter approach could create a precedent in which students (pupils) with a too divergent range of English proficiency would be involved in the experiment, which directly affects the quality and purity of the research (VOSviewer, 2023).

Besides, the proposed evaluation method used in this study has a specified and internationally recognized scale. Accordingly, it is objective and enables a thorough evaluation of the results of empirical research, in contrast to the vague, albeit affirmative assumption about the positive impact of generative methods in learning English made by Swanson et al., (2019).

The results, and the research itself, are fully and harmoniously integrated into the general concept of *Generative Second Language Acquisition*, formed in the systematized and thorough study of Slabakova et al., (2020). In this study, it is also recommended to implement an experimental method of English course learning using generative methods. Modern digital software tools and online platforms (resources) shall be involved in this process as an alternative to typical learning methods at the student's discretion. They need to be appropriately adapted and coordinated with the regulatory framework of universities and the Ministry of Education and Science of Ukraine.

7. Conclusions

The relevance of the results of this study indicates an urgent need to review and modernize established educational regulations and standards. The reason is that the latter do not integrate modern and effective educational teaching methods, including generative learning methods.

Empirical studies finally confirmed the advanced hypothesis about the appropriateness of applying a generative learning strategy in the English language course. The indicators of English language proficiency had greater dynamics towards improvement in the experimental group, which studied using the generative method and individual-general schedule with the involvement of mobile devices and online platforms, compared to the students of the control group (8.92% vs. 3.06%, respectively).

According to the research results, it is advisable to introduce an experimental course of generative learning of the English language as an alternative method at the student's discretion with appropriate adaptation to the educational requirements of higher educational institutions and the Ministry of Education and Science of Ukraine.

After broader research (provided positive results), it is advisable to arrange and unify the methodological framework in the generative study of the English language in the general concept of *Generative Second Language Acquisition*. It is also reasonable to develop an appropriate educational standard that will allow the achievement of national goals on the path of Ukraine's integration into the European Union.

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