

From Reflection to Self-assessment: Methods of Developing Critical Thinking in Students

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Summary

The research paper presents the results of an experimental research of the development of critical thinking in third-year students majoring in 013 “Primary Education” in studying a special course “From Reflection to Self-Assessment: Critical Thinking Skills” (based on Lauren Starkey methodology). The research was conducted during the first half of 2019–2020 academic year. The sample representativeness was ensured by the method of random selection, the strategy of randomization according to the criteria of age, gender, level of academic performance was described. Given the confidence interval $p=95\%$ and the confidence interval of the error $\Delta=\pm 0.05$, the sample size was 94 people, including of the experimental group and 49 students of the control group. The peculiarities of the development of such critical thinking skills as reflective thinking, self-analysis, awareness of one’s own achievements and shortcomings, choice of problem-solving strategy, use of cognitive models of learning are revealed. It was found that the development of critical thinking was achieved through a comprehensive combination of self-assessment and reflection, performing exercises to develop the ability to clearly articulate the problem, find, analyse and interpret relevant information, draw the right conclusions and explanations.

Keywords:

critical thinking, reflection, self-assessment, cognitive models of learning, metacognitive awareness.

1. Introduction

One of the most important skills that will ensure the success of professional activities in the 21st century is critical thinking. The global recession of 2020 caused by the

COVID-19 pandemic and related changes in the labour market have led to an increase in the popularity of such skills as critical thinking, analysis and problem solving [1]. Critical thinking belongs to soft skills, and its development becomes more important over time, as this is the type of skills that cannot be automated [2].

Critical thinking means the ability to objectively analyse information and make reasoned judgments. It includes an assessment of data, facts, observed phenomena and research results [3]. According to a survey conducted by the American Management Association (AMA), business leaders believe that to develop their business they need employees who have the 4C competencies, that is critical thinking/problem solving, communication, collaboration and creativity. At the same time, most respondents believe that their current employees do not have these skills at the required level. Therefore, management needs to eliminate gaps in these skills to compete in the global market in the future [4].

This applies not only to business, but also to other areas, including education, which gives grounds to focus efforts on developing critical thinking skills in future secondary school teachers in order to teach children these skills and prepare them for future challenges in the labour market. That is why the aim of our study is to determine the methods of developing critical thinking skills in future teachers during their studies in higher educational institutions.

2. Literature Review

The review of the relevant scientific literature shows the growing attention of teachers to the use of various methodologies for the development of students' critical thinking. An important problem is the definition of critical thinking. As noted in [5], the definition of critical thinking "has become so broad that it can cover almost anything and everything." Instead, the authors suggest that in addition to teaching critical thinking, special attention should be paid to teaching students scientific thinking, that is the ability to generate, verify and evaluate statements, data and theories.

Nold [6] cites data from his own research project, which consisted of implementing a curriculum of three business courses to increase self-assessment of intentions for success, including such criteria as internal purposefulness, self-efficacy and critical thinking.

Vuojärvi [7] implemented a research project to implement a course in forest bioeconomics, built on critical thinking and other skills of the 21st century (joint design, problem solving, cross-border integration, online and blended learning). The results of the qualitative analysis showed that there are some differences in the experience of students who studied with the use of blended methodology and with the introduction of online courses.

The results of Trisdiono's [8] research show that students' critical thinking and collaboration skills can be significantly improved through a multidisciplinary integrated approach relying on project-based learning by combining subjects, competencies and skills to be developed. A study by a group of Indonesian researchers demonstrated the effective impact of problem-based learning strategies on the development of students' critical thinking skills in public education. The authors note that graduates have problems at work due to insufficiently developed skills of critical thinking and problem solving. Conversely, students who think critically and creatively are able to adapt more quickly to the changing world of career development [9].

Another study focused on the effectiveness of the use of smart technologies in the development of critical thinking of law students. According to the authors, the combination of the potential of smart learning technologies and the development of critical thinking in students allows to optimally resolve the contradictions between the needs of modern society and the practice of legal training [10].

The study [11] is worth noting, which reveals the content of teaching the effective use of reasoning skills, and, according to the authors, the reasoning of individual students is often biased, while reasoning and discussion in groups give better results. However, the paper provides

suggestions for maximizing the thinking capacity of individual students.

It is emphasized in the study [12] that critical thinking is a universal competence that students need, both in future professional activities and in personal life. Therefore, it should be included in university curricula, programs and classes. The article analyses the methods used to develop critical thinking by teachers from Spain and Latin America. Summarizing the results of the study, the authors conclude that teachers prefer three methods: oral and written thinking and argumentation; reading, analysis and generalization; thematic research, regardless of the concepts of their critical thinking.

Şenol [13] studied the development of critical thinking through learning strategies in English classes. The authors propose strategies that include communicative language assignments, the use of authentic meaningful texts, critical literacy, awareness of holistic brain development, acceptance of reflective learning. According to the authors, the integrated use of surveys, collaborative learning, the use of literature in English lessons, creative drama and self-assessment allows students to become autonomous and succeed in learning.

The effectiveness of the method of asynchronous online discussion (AOD) in the development of critical thinking skills was proven in a study [14]. The author argues that the advantages of the AOD method are the ability for students to learn anytime, anywhere, as well as the time required to process learning material, exchange ideas and points of view. The effectiveness of the method depends on the number of groups participating in the training.

Norris [15] emphasized the importance of critical thinking skills and reflective thinking for MBA students. The author argues that these skills allow professionals to make effective decisions, take into account the consequences of their attitudes and actions, as well as make changes in the trajectory of effective work. At the same time, he notes that the MBA is completely detached from the "real world" and has nothing to do with the needs of practicing managers. These effects of critical thinking are fully related to the training of teachers in higher educational institutions, and should be taken into account in the preparation of the content and selecting methods of their teaching.

3. Methods

The experimental technique involved the development of critical thinking skills in third-year students majoring in 013 "Primary Education". The sample representativeness was ensured by random selection from the general population of 125 people. Given a confidence interval

$p=95\%$ and a confidence interval of error $\Delta=\pm 0.05$, the sample size was 94 people, divided into the experimental group (EG) of 45 students and a control group (CG) — 49 students. The groups were equalized using a randomization strategy according to the following criteria: age, gender, level of academic performance, the level of critical thinking.

The experiment was conducted according to the scheme “Before-after with the control group”. EG students studied a special course “From Reflection to Self-Assessment: Critical Thinking Skills”, which was delivered

during the first half of the 2019-2020 academic year. The following methods were used in the study: Socratic Dialogue, Basket of Ideas, Osborne’s brainstorming, Aquarium, Six Thinking Hats by E. de Bono, Design in Teams, Writing Essays. The control group students were trained without the introduction of this special course.

The level of critical thinking was diagnosed using the Critical Thinking test by Starkey [16] adapted by Lutsenko [17]. Table 1 contains benchmark data for the test for students.

Table 1: Benchmark data for the test of critical thinking by Starkey (adapted by Lutsenko)

| Sample | Sample size | Level of development | | | | |
|----------|-------------|----------------------|-----------|--------------|------------|-----------------|
| | | Very low level | Law level | Medium level | High level | Very high level |
| Students | 237 | <7 | 7–10 | 11–20 | 21–25 | >25 |
| Male | 65 | <7 | 7–10 | 11–19 | 20–23 | >23 |
| Female | 172 | <6 | 6–10 | 11–21 | 22–26 | >26 |

We can see from Table 1 that the indicators of the levels of male and female critical thinking differ slightly, but these differences are not significant. Given that the EG and CG were homogeneous in terms of gender, we took the averages given in the line “Students”.

The diagnostic procedure consisted of providing each student with texts of questions, each offering four possible answers. According to the instructions in all assignments (except for the first one), it was necessary to choose one of the most correct answers. The subject was awarded one point for each match of the answer with the key. There were 30 minutes for the test, and the assignments for which there were not enough time were considered uncompleted. Students who received less than 7 points on the test were considered to have a very low level of critical thinking. The result of 7–10 points corresponded to a low level, 11–20 points corresponded to a medium average level, 21–25 — to a high level, and more than 25 points — to a very high level.

Academic performance was determined by the ECTS system (European Credit Transfer and Accumulation System): a high level correlated with “A” grade (90-100 points), a sufficient level “B” and “C” grades (75-89 points), a medium level corresponded to “D” and “E” grades (60-74 points), the low — to “FX” (36-59) and “F” (1-35 points) grades. The assessment procedure was conducted by the Examination Board consisting of Head of the Primary Education Department and two teachers who taught the specified experimental course.

4. Results

To establish a starting point in the situation “before the experiment”, we diagnosed critical thinking in EG and CG. Table 2 provides diagnostic results.

Table 2: Levels of critical thinking in students of EG and CG (“before the experiment” situation)

| Levels | Experimental group | | Control group | |
|-----------|--------------------|------|---------------|------|
| | People | % | People | % |
| Very high | 0 | 0 | 0 | 0 |
| High | 8 | 18.0 | 10 | 21.0 |
| Medium | 27 | 60.0 | 31 | 63.0 |
| Low | 10 | 22.0 | 8 | 26.0 |
| Very low | 0 | 0 | 0 | 0 |
| Total: | 45 | 100 | 49 | 100 |

Statistical analysis of data in Table 1 showed that there were no students with very high and very low levels of critical thinking in both EG and CG. The rest of the data in Table 2 were distributed as follows: a high level of the

studied trait was recorded in 18% of students in the experimental group and in 21.0% of the control group; medium level — in 60.0% and 63%; low — in 22.0% and 26%, respectively. The calculation of Pearson’s chi-squared

test indicates almost the same distribution of respondents' shares according to the levels of critical thinking (empirical value $\chi^2=0.551$, critical value χ^2 at the significance level $p<.05$ is 5.991).

We also compared the performance of students of EG and CG in the situation "before the experiment" (Table 3).

Table 3: Levels of academic performance of EG and CG students ("before the experiment" situation)

| Levels of academic performance | Experimental group | | Control group | |
|--------------------------------|--------------------|------|---------------|------|
| | People | % | People | % |
| High | 3 | 7.0 | 4 | 8.0 |
| Sufficient | 14 | 31.0 | 14 | 29.0 |
| Medium | 22 | 49.0 | 25 | 51.0 |
| Low | 6 | 13.0 | 6 | 12.0 |
| Total: | 45 | 100 | 49 | 100 |

The data of Table 3 show that the distribution of student shares by levels of academic performance is identical: a high level was recorded in 7% of EG and 8% of CG. Similarly, a sufficient level was recorded in 31% and 29%, medium — in 49% and 51%, low — in 13% and 12%. In summary, we can say that the discrepancy between the particles is one to two percent. This trend is confirmed by statistical calculations: the empirical value of χ^2 is 0.164, while the critical value of χ^2 at a significance level of $p<.05$ is 7.815. Thus, the above calculations confirm the lack of significant differences between EG and CG in the levels of student academic performance.

The conducted testing and comparison of academic performance data showed the homogeneity of the formed groups of students, which is an important condition for establishing or refuting the effectiveness of the experimental methodology.

Teaching of the special practical course ended with the final testing of EG and CG students using the Critical Thinking test of L. Starkey adapted by Lutsenko (Table 4).

Table 4: Levels of critical thinking in students of EG and CG ("post-experiment" situation)

| Levels | Experimental group | | Control group | |
|-----------|--------------------|------|---------------|------|
| | People | % | People | % |
| Very high | 3 | 7.0 | 0 | 0 |
| High | 17 | 38.0 | 11 | 23.0 |
| Medium | 25 | 55.0 | 32 | 65.0 |
| Low | 0 | 0 | 6 | 12.0 |
| Very low | 0 | 0 | 0 | 0 |
| Total: | 45 | 100 | 49 | 100 |

Analysis of table 4 showed significant differences between EG and CG (the empirical value of χ^2 is 10.995, which exceeds the critical value $\chi^2=7.815$ at a significance level of $p=0.05$). First of all, it should be noted that in EG 3 students (7%) developed critical thinking to a very high level, while CG students didn't demonstrate this. The share of students with a high level has considerably increased in EG in comparison with CG: 38% as opposed to 23%, that is the difference makes 15%. In addition, 6 EG students (13%) increased their level from low to medium, while this figure remained unchanged in CG.

For a more detailed analysis, we will compare the changes in the EG before and after the experiment (Table 5).

Analysing Table 5, we can see that the number of EG students with a high level more than doubled (17 vs. 8), and three students reached a very high level of critical thinking as a result of the conducted experimental work. Instead, 10 students who had a low level raised it to a medium level. The statistical significance of these changes is confirmed by the value of χ^2 (16.317), which exceeds the critical value (11.345) at a significance level of $p<0.01$.

Table 5: Changes in the levels of critical thinking in EG students (comparison of situations “before the experiment” and “post-experiment”)

| Levels | After the experiment | | Before the experiment | |
|-----------|----------------------|------|-----------------------|------|
| | People | % | People | % |
| Very high | 3 | 7.0 | 0 | 0 |
| High | 17 | 38.0 | 8 | 18.0 |
| Medium | 25 | 55.0 | 27 | 60.0 |
| Low | 0 | 0 | 10 | 22.0 |
| Very low | 0 | 0 | 0 | 0 |
| Total: | 45 | 100 | 45 | 100 |

The obtained results were also characterized by qualitative features. Thus, three students (7%) achieved a very high level of test performance. This meant that they had developed skills of critical thinking, such as logic, induction, deduction, reflection. They can control their emotions well, analyse information for authenticity, have the ability to recognize their illusions, manipulation by others, advertising, propaganda.

In addition, they are able to separate estimates and assumptions from the facts, identify causal relationships or accept their absence, recognize the limitations of their mental processes, make the most optimal decisions in conditions of uncertainty and risk. Therefore, they are able to set realistic goals and find adequate ways to achieve them. Such competencies enable them to be an effective professional in all types of work, which requires complex and responsible decisions, as well as give a general advantage in life and adaptation to changing conditions of the environment.

There were 17 students (38%) who received a high level for the test. These students have the majority (80-90%) of critical thinking skills — logic, induction and deduction, control over emotions, are critical of persuasion and manipulation techniques, are able to set goals and build a strategy to achieve them. However, some critical thinking skills may not be available at this level. For example, these include the most complex processes of information analysis and thinking — screening or re-examining pseudo-reliable sources of information, resistance to distraction techniques, distrust of evaluative judgments instead of facts, identifying real problems rather than “catchy” (which may not actually require a solution), deep reflection. According to the author of the test, such a person can achieve a higher level of critical thinking, if he develops it in accordance with the proposed training and programs for the development of critical thinking. The medium test results were obtained by 25 EG students (55%). Each student at this level has a significant number (30-70%) of critical thinking skills — logic, including advanced induction and deduction procedures, the ability to critically analyse information, a certain ability to resist manipulation (being probably not immediately aware of them), control over emotions and

understanding of their influence on decision-making. At the same time, these abilities are underdeveloped because such students did not correctly recognize 30 to 70% of persuasion techniques: distraction, erroneous conclusions, did not choose optimal solutions and trusted unreliable sources of information that were simulated in the test. The author of the test claims that the number of optimal decisions in such individuals may be approximately equal to the number of unsuccessful ones, but based on knowledge of successful decisions, they may not realize the lack of efficiency and limitations of their thinking. Therefore, at this level of critical thinking, the student must allocate time and energy for its development, as this can be a serious growth potential for him. There were low test scores in 10 (22%) EG students before the experiment. This showed that these students did not have enough critical thinking skills (less than 30%), which often leads to mistakes, unsuccessful decisions, accumulation of problems in learning and life in general. Such people can often be a victim of manipulation, propaganda, unfair advertising; they can fall victim to scammers and manipulators without even realizing it. They may perceive clever manipulators as their true friends or benefactors, while honest and reliable people — as enemies or foes. People with a low level of blurred critical thinking cannot effectively build arguments, and therefore will often encounter misunderstandings in discussions, which turns into useless and unconstructive arguments, may feel offended, underestimated, will tend to mystical and fatal explanation of the world, because objective and logical explanation is not available enough to them. Such people can often be disappointed in different people, ideas, processes, because they tend to entertain illusions that do not correspond to reality, develop ineffective behavioural strategies. In this case, the author of the test strongly recommends the development of critical thinking skills in all available ways.

A very low level of the test indicates that this individual copes with only 10-20% of assignment that require the use of critical thinking. Although there was no student among those who participated in the experiment who received very low scores for the test, they were introduced to different levels (including very low) of critical thinking while studying the proposed special course. Thus,

subjects with a very low level of critical thinking have poorly developed logic, induction and deduction processes, the ability to filter out inaccurate information and collect objective one, detect manipulations, illusions and misconceptions, make informed decisions, argue, realize own biases. People with this level feel incomprehensible or incompetent in intellectual disputes. They will try to cheat, dodge or resort to aggression, as they are not able to provide clear and convincing arguments. These subjects are characterized by various substitutions of thinking by beliefs.

Such people often get to totalitarian sects or become supporters of right-wing radical and authoritarian

ideologies, they may distrust science and oppose the dissemination of knowledge, they may have alcohol, gaming, television and other addictions. They obey ancient instincts and make little use of the adaptive capabilities of the mind. In addition, they often do not realize their own mistakes, they become “pawns” in someone else’s game.

Changes in the learning performance of EG and CG students were also studied in the “post-experiment” situation. For this purpose, Table 6 presents the generalized results of academic performance for the semester.

Table 6: Levels of academic performance of EG and CG students (“post- experiment” situation)

| Levels of academic performance | EG | | CG | |
|--------------------------------|--------|------|--------|------|
| | People | % | People | % |
| High | 9 | 21.0 | 4 | 8.0 |
| Sufficient | 20 | 44.0 | 16 | 33.0 |
| Medium | 16 | 35.0 | 25 | 51.0 |
| Low | 0 | 0 | 4 | 8.0 |
| Total: | 45 | 100 | 49 | 100 |

Comparison of indicators of academic performance provided in Table 6 showed that the share of EG students with high and sufficient levels of success is 65%, while this figure is 41% in CG. The differences between EG and CG are confirmed by statistical calculations: the calculated value of χ^2 is 8.188 with a critical value of this criterion 7.815 at a significance level of $p < 0.05$.

The above gives reason to believe that as a result of the experiment, the academic performance of EG students has significantly improved in comparison with CG. However, the question arises as to how significant were the changes in EG after the experiment compared to the situation before the experiment. The relevant data were entered in Table 7 to clarify this.

Table 7: Changes in the academic performance of EG students

| Levels of academic performance | After the experiment | | Before the experiment | |
|--------------------------------|----------------------|------|-----------------------|------|
| | People | % | People | % |
| High | 9 | 21.0 | 3 | 7.0 |
| Sufficient | 20 | 44.0 | 14 | 31.0 |
| Medium | 16 | 35.0 | 22 | 49.0 |
| Low | 0 | 0 | 6 | 13.0 |
| Total: | 45 | 100 | 45 | 100 |

Analysis of Table 7 shows that the academic performance rates in EG significantly improved after the experiment. In particular, the number of students with high level doubled to 6 as opposed to 3 before the experiment. Instead, the number of intermediate and low-level students decreased to 16 and 3, respectively, compared to 22 and 6 in the “pre-experiment” situation. The analysed changes are confirmed by statistical calculations: the empirical value of

χ^2 is 11.006, while the critical value of χ^2 is 7.815 at a significance level of $p = 0.05$.

One of the objectives of our study was to establish the impact of the development of critical thinking on student academic performance. Table 8 was prepared in order to test this hypothesis, which contains generalized data of EG students on the levels of critical thinking (factor trait) and academic performance (resulting trait).

Table 8: The impact of the development of critical thinking on the academic performance of EG students

| Levels of critical thinking | Levels of academic performance | | | | Total |
|-----------------------------|--------------------------------|------------|--------|-----|-------|
| | High | Sufficient | Medium | Low | |
| Very high | 3 | 0 | 0 | 0 | 3 |
| High | 6 | 11 | 0 | 0 | 17 |
| Medium | 0 | 9 | 16 | 0 | 25 |
| Low | 0 | 0 | 0 | 0 | 0 |
| Very low | 0 | 0 | 0 | 0 | 0 |
| Total | 9 | 20 | 16 | 0 | 45 |

As the results of diagnostics in the group did not record low and very low levels of critical thinking, as well as low levels of academic performance, cells with zero values were not taken into account to calculate the statistical criterion χ^2 and the Chuprov's correlation. Therefore, the calculated Chuprov's coefficient is equal to $C=0.458$, and is statistically significant at the confidence level $p<.01$ (the value of the calculated χ^2 is 32, 693, the critical value of χ^2 at the significance level $p=0.01$ is 13.277, so the correlation between factor and resulting traits is statistically significant at a significance level of $p<0.01$). Thus, the influence of the development of critical thinking on improving academic performance can be considered proven.

5. Discussion

The results obtained during the experimental study were achieved through the consistent development of a wide range of skills that are part of critical thinking in students. The most important of them is reflexive thinking, as it enables students to conceptualize critical reflection as a process that enhances self-awareness, promotes the application of theory in practice, and reinforces aspects of their professional identity [18]. In addition, reflexive thinking is an effective cognitive tool for understanding their own strengths and weaknesses, in choosing strategies for solving problems.

Fen-Fang in [19] proved the influence of self-reflection on the development of critical thinking was proved in their study: respondents who believed they had more introspection and understanding reported more critical thinking in their professional activities. Metacognitive awareness, which means the ability of an individual to realize and regulate the process of self-knowledge, is close to the concept of self-reflection. The study [20] found that when students are able to control their cognitive processes, they approach the facts given to them more critically and more judiciously evaluate the information they receive from the environment. The authors found that the development of metacognitive awareness skills leads to an increase in the level of critical thinking.

Much attention in the experimental work was paid to the development of metacognition skills through careful selection of questions using different cognitive models, in particular, Socratic dialogue, Paul & Elder taxonomy, which helped students learn to think correctly and ask questions. In particular, Nappi [21] emphasizes this aspect of the problem in his study.

Ghanizadeh [22] confirms the effectiveness of this combination of methods in his study: he evaluated the correlation between higher-order thinking skills (reflexive thinking, critical thinking) and self-control, which contribute to the academic performance of university students. The results of the study showed that critical thinking and all components of reflective thinking have a positive and reliable impact on academic performance, with reflection and self-control having the greatest impact.

Significant progress in teaching critical thinking has been achieved through a combination of self-assessment and reflection of students during the pre-test, as well as during the completion of special exercises to develop competencies such as the ability to clearly formulate problems, find, analyse and interpret relevant information, draw correct conclusions and make explanations [1].

Strakova and Cimermanova [23] noted in their study that an important way to solve the problems of sustainable development is the formation of critical thinking skills in students-future teachers. The study found a positive impact of the use of case studies on the development of their critical thinking skills.

In delivering the experimental special practical course we used the method of teamwork. In addition to developing critical thinking skills, this method had a positive effect on the development of students' ability to interact and cooperate, which is also confirmed by research [24].

We found in our study that those students who had a higher level of desire for truth-seeking and self-development had the best results in the development of critical thinking. This raises the question of the need for separate studies of the impact of such dispositions as

curiosity, openness, systematicity, truth-seeking, self-confidence, maturity on critical thinking.

Another aspect that needs further research is the introduction of the development of critical thinking in the higher education system of Ukraine, as it is essential for the socio-economic development of the country. In particular, Hamzah [25] draws attention to this in his study of the state of teaching critical thinking in educational institutions in Indonesia.

6. Conclusion

The results of the study showed the effectiveness of developing critical thinking in students in teaching a special practical course. The EG (45 people) was formed using the method of random selection, where students studied a special practical course delivered during the first half of the 2019-2020 academic year. This course was not delivered in the CG (49 people). The level of critical thinking was diagnosed using the L. Starkey's Critical Thinking test adapted by O. Lutsenko.

Interpretation of the test results allowed dividing EG students into very high, high, medium, low and very low levels of critical thinking, as well as providing qualitative characteristics. According to the results of the experiment in EG, the number of students with a high level has more than doubled. Besides, we proved that the development of critical thinking has a positive effect on academic performance: the number of students with a high level doubled, and the number of students with a low level decreased.

The obtained results were achieved due to reflexive thinking, self-analysis, awareness of one's achievements and shortcomings, ability to choose a strategy for solving problems. This was also facilitated by metacognitive awareness skills: students learned to critically and thoughtfully analyse and evaluate information and make informed decisions; correctly use cognitive models of learning (Socratic dialogue, Paul & Elder taxonomy, which helped them to think correctly and ask questions). The success of experimental learning was achieved through a comprehensive combination of self-assessment and reflection, performing exercises to develop the ability to clearly articulate the problem, find, analyse and interpret relevant information, draw the right conclusions and explanations. Further research is needed on the role of dispositional self-regulation of an individual in the development of critical thinking skills, as well as the impact of critical thinking on the professional success of graduates of pedagogical specialties.

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