# Turning the Classroom Inside Out: Investigating Flipped Classroom for Programming Olympiad in High School

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***Abstract.*** *The Brazilian Olympiad in Informatics is an annual competition aimed at basic education students, focused on solving challenges through programming languages. This study presents a controlled experiment conducted in a free preparatory course offered to high school students from a public school in Ceará, Brazil,, aiming to evaluate the impact of the Flipped Classroom methodology in comparison to the traditional approach. Theoretical content was delivered remotely, while practical activities took place in person. The results showed improvements in learning, increased student engagement, and strong performance in the Olympiad, with three students qualifying for the state phase and one for the national phase.*

***Resumo.*** *A Olimpíada Brasileira de Informática é uma competição anual destinada a estudantes da educação básica, cujo foco é a resolução de desafios por meio de linguagens de programação. Este trabalho apresenta um experimento controlado realizado em um curso preparatório gratuito ofertado a alunos do ensino médio de uma escola pública cearense, visando avaliar o impacto da metodologia de Sala de Aula Invertida em comparação com a abordagem tradicional. Os conteúdos teóricos foram entregues em formato remoto, enquanto as práticas ocorreram presencialmente. Os resultados demonstraram avanços na aprendizagem, maior engajamento dos alunos e bom desempenho na olimpíada, com três classificações para a fase estadual e uma para a fase nacional.*

## 1. Introduction

This study presents the results of a controlled experiment comparing two instructional methodologies for teaching computer programming to high school students preparing for the Brazilian Olympiad in Informatics (OBI). The research was conducted at "Escola de Ensino Médio Tancredo Nunes de Menezes/Tianguá", a public high school in the state of Ceará, Brazil, with the goal of evaluating the effectiveness of the Flipped Classroom approach in contrast to the traditional lecture-based model.

The school does not offer formal instruction in computer programming, computational thinking, or digital technologies, despite national educational initiatives such as the Connected Education Innovation Program [MEC 2018] and the guidelines of the National Common Curricular Base (BNCC) [MEC 2017], which emphasize the development of digital competencies. This gap highlights the need to integrate programming education into the school curriculum, especially considering the growing demand for Information Technology (IT) professionals in Brazil.

As a response to this educational and market demand, the OBI offers an opportunity to introduce students to programming in a motivating and competitive environment [OBI 2022]. The school's recent participation in the OBI aligns with broader national trends, where an increasing number of public and private schools are encouraging students to engage with computational knowledge through competitions. The presence of over 26,000 participants in the 2023 edition, including students from 219 schools in Ceará[1], highlights this growing interest.

This study aims to evaluate the impact of the Flipped Classroom methodology in comparison to traditional teaching methods in the context of preparing high school students for the OBI. The research contributes to the broader educational movement by incorporating programming instruction through both conventional and active learning approaches. The impact was assessed through a comparative analysis of learning outcomes, student engagement, and motivation between participants exposed to the Flipped Classroom model and those taught using traditional lecture-based methods. The structure of this document is as follows: Section 2 presents the theoretical background and related work; Section 3 details the methodological procedures and technological tools; Section 4 reports the results and discusses key findings; and Section 5 provides the final conclusions, limitations and recommendations for future work.

## 2. Background

### 2.1. Flipped Classroom

The Flipped Classroom is an active learning methodology that combines asynchronous access to theoretical content with synchronous, in-person practical activities. It emphasizes student engagement and autonomy, encouraging learners to construct knowledge through interaction rather than passive reception [Barbosa and de Moura 2013]. Content delivery occurs prior to class—typically through videos or curated study guides—while classroom time is reserved for practical, collaborative exercises [Bergmann and Sams 2012].

This method enables instructors to act as facilitators, guiding students through applied activities that reinforce pre-studied concepts [Berrett 2012]. Empirical evidence supports its effectiveness. For instance, [Olivindo et al. 2021] report positive results using Flipped Classroom combined with gamification in a Software Engineering course, including significant learning gains and favorable student feedback. Similarly, [Martins et al. 2019] demonstrate superior learning outcomes among students exposed to FC compared to those in traditional lectures.

The FC model typically follows a three-stage cycle: (a) pre-class, where students engage with the content; (b) in-class, where teachers mediate learning through practice; and (c) post-class, where feedback informs future instruction [Schmitz et al. 2016]. Successful implementation requires careful planning and selection of instructional materials aligned with learning objectives.

[1] Available (in Portuguese) at: `https://olimpiada.ic.unicamp.br/consultas`

### 2.2. Brazilian Common Curricular Base (BNCC)

The BNCC defines ten general competencies for Basic Education, including Competency 6, "Digital Culture", which emphasizes the critical and ethical use of digital technologies for communication, knowledge production, and problem-solving [MEC 2017]. It encourages the development of programming skills, algorithmic thinking, and digital literacy. Despite these guidelines, public schools face challenges in implementation, particularly regarding access to technological resources [Gontijo 2015]. At EEM Tancredo Nunes de Menezes, the scarcity of computers, tablets, and audiovisual equipment limits the integration of digital technologies. The lack of infrastructure hinders the effective application of Competency 6.

Curriculum models proposed by the Innovation Center for Brazilian Education (CIEB) offer structured pathways to integrate digital education, drawing from international experiences. These frameworks promote student autonomy and critical engagement with technology [Raabe et al. 2018].

### 2.3. Brazilian Olympiad in Informatics (OBI)

The OBI, organized annually by the Brazilian Computer Society (SBC), aims to stimulate interest in computing among students from elementary to high school levels[2]. It introduces computational thinking and programming through a structured competition divided into two tracks: Initiation and Programming, each with multiple levels. Participants compete individually, solving problems that range from basic input/output and conditionals to complex algorithmic challenges involving graphs, dynamic programming, and computational geometry. Mastery of at least one programming language is required.

OBI serves both as a motivational tool and as an educational strategy aligned with national curricular goals, offering recognition and advancement opportunities for students interested in computer science.

### 2.4. Related Work

Some works have explored the integration of computational thinking and programming into basic education. The "*Pensa RN*" program, for example, is a state-wide initiative led by the Federal University of Rio Grande do Norte to promote computational thinking through teacher training and student courses [Nunes et al. 2021]. This project highlight the use of computational thinking to enhance mathematical reasoning. Students not only provided final answers but also detailed their reasoning processes, demonstrating deeper cognitive engagement.

[Lopes et al. 2019] report on a preparatory course for the OBI targeting students aged 14 to 16. The course led to a high success rate in exercises and notable participation in state and national OBI phases, underscoring the potential of structured training. [Rossi et al. 2021] describe a similar extension project at the Federal Institute of Santa Catarina, which included a preparatory mini-course for local schools. The results from 2020 showed meaningful student participation, with some advancing to the national level.

Although most related works employed traditional, lecture-based methodologies, the present study adopts a student-centered approach through the Flipped Classroom. The

[2] Available (in Portuguese) at: `https://olimpiada.ic.unicamp.br/info/`

key differences between these initiatives and the current research are summarized in Table 1.

**Table 1. Comparative summary of related works and the present study**

| Work | Teaching Methodology | Programming Language | Tools and Platforms |
|---|---|---|---|
| [Nunes et al. 2021] | Expository classes | Python | URI Online Judge |
| [Rossi et al. 2021] | Expository classes | C | Not specified |
| [Lopes et al. 2019] | Expository classes | Not specified | OBI material and custom exercises |
| **Our Study** | Flipped Classroom and Expository classes | Python | Run.codes, Visual Studio Code, Edpuzzle, Google Forms, Study Guides |

## 3. Study Design

This study was approved by the Ethics Committee of IFCE[3], and authorization for implementation was formally granted by the school.

### 3.1. Participants

Data collection occurred during one month at EEM Tancredo Nunes de Menezes. Forty-two high school students participated in the study, randomly assigned to two groups: an experimental group (22 students) exposed to the Flipped Classroom methodology, and a control group (20 students) taught using traditional lectures. All students were beginners in programming, with no prior exposure to the OBI context. The same instructor conducted all sessions.

### 3.2. Materials and Data Collection Instruments

The instructional content was delivered using a printed study guide[4]. Activities included theory-focused sessions, practical programming exercises, and a final OBI-style simulation. Data collection instruments consisted of:

- A pre-test and post-test to assess learning outcomes;
- Engagement tracking via submission of exercises;
- The Motivated Strategies for Learning Questionnaire (MSLQ) [Pintrich et al. 1991] to assess student motivation.

The MSLQ was adapted to the high school context and administered through Google Forms using a Likert scale [Likert 1932]. The 31-item questionnaire measured intrinsic and extrinsic goal orientation, task value, control of learning beliefs, self-efficacy, and test anxiety [Salvador et al. 2017, Neo et al. 2020, Xavier 2020]. Responses ranged from 1 (strongly disagree) to 7 (strongly agree).

[3] Approval: CAAE 63646022.2.0000.5589; Opinion no. 5.757.269

[4] Available (in Portuguese) at: `https://drive.google.com/file/d/12uRlGj2HHnanNLncuw3yUw1DAcDudwci/view?usp=sharing`

### 3.3. Instructional Procedure

The quasi-experimental design compared two instructional strategies: traditional lectures and the Flipped Classroom model. Both groups followed the same curriculum over six 4-hour sessions (24 hours total). The experimental group studied theoretical content asynchronously and applied it during class; the control group received direct instruction followed by exercises. Figure 1 illustrates the experimental flow inspired by [Pereira et al. 2019].

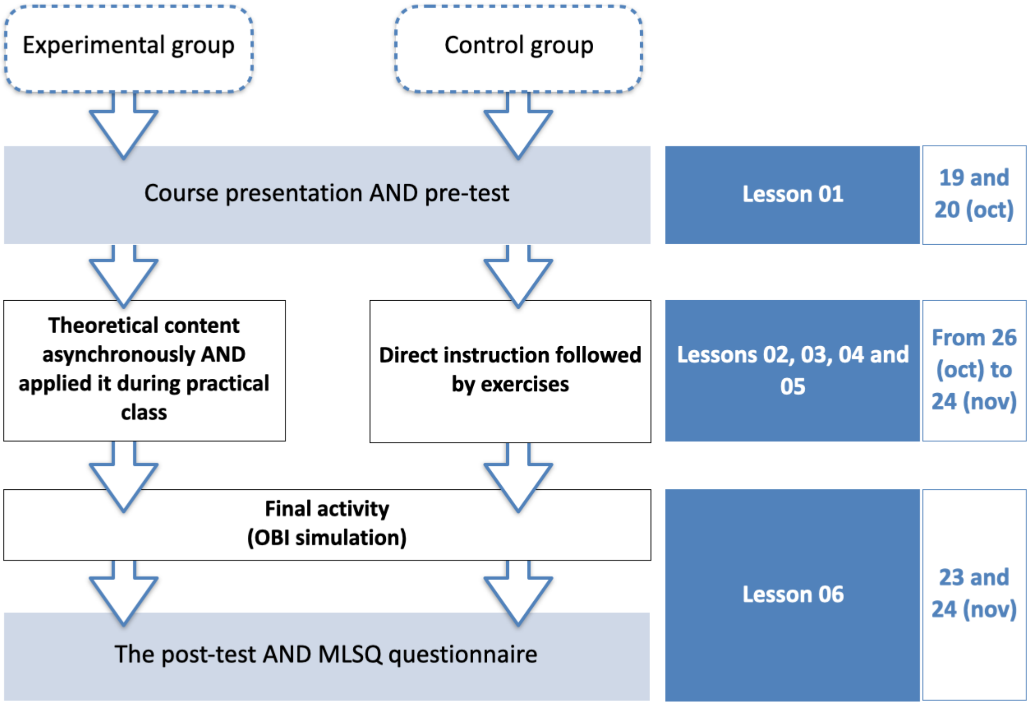


**Figure 1. Experimental design overview**

In both groups, the first session included a course overview and pre-test. The final session featured an OBI-style simulation, the post-test, and administration of the MSLQ questionnaire. Learning performance was measured by comparing pre- and post-test scores. Student engagement was evaluated by the number and quality of completed exercises. Table 2 compares the distribution of theoretical and practical hours across both groups. While the total instructional time remained equivalent (20 hours), the Flipped Classroom model allocated a greater proportion to hands-on practice during class sessions.

### 3.4. Technological Tools

Python was the programming language adopted due to its readability, accessibility, and broad applicability. The Visual Studio Code editor[5] was used as integrated development environment.

Run.codes platform[6] was used for automated exercise evaluation, allowing students to submit and receive instant feedback on their code. For the Flipped Classroom

[5] `https://code.visualstudio.com`
[6] `https://github.com/runcodes-icmc`

**Table 2. Instructional time comparison between teaching methods**

| Session | Topics Covered | Traditional (hrs) | | Flipped Classroom (hrs) | |
|---|---|---|---|---|---|
| | | Theory | Practice | Theory | Practice |
| 01 | OBI rules, VS Code, run.codes, Python intro, Pre-test | 3.0 | 1.0 | 3.0 | 1.0 |
| 02 | Algorithms, variables, strings, numbers | 3.0 | 1.0 | 1.5 | 2.5 |
| 03 | Numeric operators, conditionals | 2.0 | 2.0 | 1.5 | 2.5 |
| 04 | Loops (while, for) | 2.0 | 2.0 | 2.0 | 2.0 |
| 05 | Data structures (lists, stacks) | 2.5 | 1.5 | 2.5 | 1.5 |
| 06 | OBI simulation, Post-test | – | – | – | – |

group, Edpuzzle[7] was used to assign and track interactive video lessons. The methodology was designed to ensure consistency between groups while isolating the instructional method as the primary variable under investigation.

## 4. Results and Discussion

### 4.1. Performance Analysis

Performance was assessed using pre- and post-tests focused on programming logic problems from past OBI exams. The control group (traditional teaching) began with 20 students, of whom 8 completed the course. The experimental group (flipped classroom) began with 22 students, with 12 completing the course. Only students who completed the entire course were included in the analysis.

Table 3 shows the pre-test scores. In the control group, 25% of students scored 7.0 or above, while in the experimental group, this percentage increased to 50%, as shown in Table 4. However, a t-test indicated no statistically significant difference between the groups ($p = 0.1595$).

**Table 3. Scores Obtained in the Pre-Test (Sorted Descending)**

| Group | Scores | | | | | | | | | | | | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Traditional | 8 | 7 | 6 | 6 | 6 | 6 | 5 | 2 | | | | | 5.75 | 1.75 |
| Flipped Classroom | 10 | 10 | 8 | 8 | 8 | 7 | 6 | 6 | 5 | 5 | 4 | 3 | 6.66 | 2.22 |

On the post-test, both groups showed improvement. Table 5 presents the results, with 75% of the control group and 91.6% of the experimental group scoring 7.0 or higher. Although both groups improved significantly ($p < 0.05$), the learning gain of the experimental group was not statistically greater than that of the control group (Table 6).

[7] `https://edpuzzle.com/`

**Table 4. Pre-Test Performance Distribution**

| Metric | Traditional Group | | Flipped Classroom Group | |
|---|---|---|---|---|
| Total students | 8 | 100% | 12 | 100% |
| Score $\geq 7.0$ | 2 | 25.0% | 6 | 50.0% |
| Score $< 7.0$ | 6 | 75.0% | 6 | 50.0% |

**Table 5. Post-Test Scores by Group (Sorted Descending)**

| Group | Scores | | | | | | | | | | | Average | SD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Traditional | 8 | 7 | 7 | 7 | 7 | 7 | 6 | 5 | | | | 6.75 | 0.89 |
| Flipped Class | 10 | 10 | 9 | 9 | 9 | 8 | 8 | 7 | 6 | 6 | 5 | 8.00 | 1.65 |

**Table 6. Student Performance on the Post-Test**

| Metric | Traditional Group (G1) | | Flipped Classroom Group (G2) | |
|---|---|---|---|---|
| Total Students | 8 | 100% | 12 | 100% |
| Score $\geq 7.0$ | 6 | 75% | 11 | 91.6% |
| Score $< 7.0$ | 2 | 25% | 1 | 8.4% |

The results of the pre- and post-tests indicate a learning gain in both groups, suggesting that both traditional and flipped classroom methodologies contributed positively to students' understanding of programming fundamentals. However, despite the slightly higher average in the experimental group, no statistically significant difference was found. This finding aligns with studies such as [Jiang et al. 2021, Sun and Wu 2022, Thai et al. 2017], which argue that short interventions with flipped classrooms may not always yield immediate measurable performance gains, but tend to foster better long-term learning and autonomy.

The final evaluation was a simulated OBI exam. The experimental group outperformed the control group with a significantly higher number of correct submissions ($p < 0.05$), as detailed in Table 7.

**Table 7. Statistical comparison of performance in simulated test**

| Metric | Control Group (C) | | Experimental Group (E) | | p-value ($E > C$) |
|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | |
| Submissions | 6.25 | 1.26 | 10.50 | 1.29 | **0.00164** |
| Correct | 3.00 | 2.45 | 8.50 | 2.38 | **0.00907** |
| Incomplete | 3.25 | 2.06 | 2.00 | 1.41 | 0.50000 |

The performance of students in the experimental group on the programming simulation was significantly superior in both the number of correct solutions and submission rates. This result may suggest that the flipped classroom methodology contributed to a more solid understanding and problem-solving autonomy, especially under the pressure of a time-limited and content-specific test. In competitions like OBI, performance is closely linked to familiarity with the format and confidence during code execution — both of which may be enhanced by the active, iterative practice enabled by flipped strategies.

Moreover, the structured exposure to preparatory materials before class may have allowed students to use class time more efficiently, clearing doubts and solidifying knowledge through peer and teacher interaction, a key benefit highlighted in the literature on active methodologies, specially regards flipped classroom.

### 4.2. Student Engagement

Engagement was evaluated based on the number of programming exercises completed on the *run.codes* platform. Both groups maintained engagement levels above 70% for most activities. However, the Mann-Whitney test revealed no significant difference in engagement between the groups ($p$ = 0.9745), as shown in Table 8. The control group exhibited slightly higher consistency in submissions.

**Table 8. Statistical comparison of student engagement**

| **Metric** | **Control Group (C)** | | **Experimental Group (E)** | | **p-value ($E > C$)** |
|---|---|---|---|---|---|
| | Median | Std. Dev. | Median | Std. Dev. | |
| Engagement | 19 | 1.92 | 17 | 2.15 | 0.9745 |

Although no statistically significant differences were found in the level of engagement between the groups, the experimental group had slightly lower engagement rates. One possible explanation may be the increased cognitive and time demands required for preparation in the flipped model, which could discourage students unaccustomed to proactive learning habits. This highlights a well-known challenge in implementing active methodologies: the need for gradual adaptation and stronger initial support, especially in environments where the traditional lecture model prevails.

On the other hand, the consistency observed in both groups reinforces the idea that when students are intrinsically motivated (as was seen later in the MSLQ), they are capable of maintaining a high level of engagement regardless of the teaching strategy adopted.

### 4.3. Student Motivation

Student motivation was assessed using the Motivated Strategies for Learning Questionnaire (MSLQ), covering three motivational components: interest, expectancy of success, and test anxiety. Both groups reported high levels of interest and expectancy (*mean* $> 5.0$), indicating positive motivation. However, the experimental group had significantly lower test anxiety scores ($p = 0.04586$), as shown in Table 9, suggesting that the flipped classroom approach contributed to greater confidence and reduced stress during assessments.

To further illustrate the motivational differences between the control and experimental groups, we plotted a radar chart (Figure 2). This visualization highlights how both groups performed across the three evaluated constructs: interest, expectation of success, and test anxiety. As observed, while both groups scored similarly in interest and success expectation, the experimental group demonstrated a noticeably lower level of test anxiety, reinforcing the statistical findings shown in Table 9. This suggests that the flipped

Table 9. Statistical comparison of motivation indicators using the Mann-Whitney test

| Scale | Control Group (C) | | Experimental Group (E) | | p-value $(E > C)$ |
|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | |
| Interest | 5.58 | 1.71 | 5.83 | 1.63 | 0.0635 |
| Success Expectancy | 5.46 | 1.89 | 5.72 | 1.61 | 0.2048 |
| Affective (Test Anxiety) | 4.57 | 2.47 | 3.72 | 2.31 | **0.0459** |

classroom approach may help reduce emotional stress during assessments, possibly due to increased student autonomy and familiarity with the content prior to class activities.

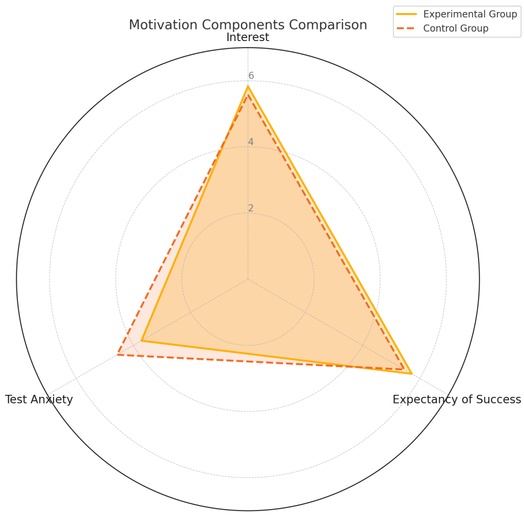


**Figure 2. Motivational comparison between groups using radar chart.**

The motivational results, particularly the reduced test anxiety in the experimental group, reinforce one of the flipped classroom's strongest arguments: students tend to feel more prepared and less pressured during assessments. This aligns with [Sun and Wu 2022, Thai et al. 2017, Chen et al. 2017], who affirm that prior exposure to content through self-paced learning increases confidence and diminishes cognitive overload during high-stakes tasks. Interestingly, despite the flipped model not leading to statistically higher "interest" or "success expectancy" scores, it showed consistent averages above 5.0 — indicating a generally positive perception of learning in both settings. The reduced anxiety may also suggest that flipped classrooms, by promoting autonomy, build emotional safety for learners facing complex problem-solving challenges such as those found in the OBI.

Both the flipped classroom and traditional methods led to improved performance and motivation among students. While no significant difference was found in engagement or learning gain, the flipped classroom approach contributed to reduced test anxiety and better performance in the simulated exam. These results support the use of active learning strategies such as the flipped classroom model in programming education for high school students. Although this study did not identify statistically significant differences in learning performance or motivation between groups — except for anxiety reduction — it revealed important pedagogical insights. The flipped classroom may not produce immediate results in short interventions, but shows promise for reducing emotional barriers and fostering deeper learning engagement, especially in computational problem-solving.

Future research should consider longer intervention periods, include qualitative feedback from students, and explore hybrid strategies that combine flipped instruction with gamification or peer tutoring, aiming to maximize both engagement and performance outcomes.

## 5. Conclusion and Limitations

This study aimed to evaluate the impact of the FC methodology compared to traditional teaching methods in preparing high school students for the OBI. The study involved two groups: a control group that followed a traditional instructional model and an experimental group that adopted the FC approach.

The results indicate that both groups showed improvement in programming performance, as measured by pre- and post-tests. However, the experimental group achieved better results in the OBI simulation and exhibited significantly lower test anxiety, as revealed by the MSLQ motivation questionnaire. No statistically significant differences were found in terms of engagement or general motivational interest, although the FC group demonstrated consistently strong performance throughout the course. These findings support the pedagogical potential of active learning methods, particularly the FC model, in teaching programming and computational thinking. The data suggest that this approach not only enhances academic performance but also helps reduce emotional stress related to testing, fostering a more supportive learning environment. Despite the encouraging results, this study presents some limitations: (a) sample size: Only 20 students completed the course (12 in the experimental group and 8 in the control group), limiting statistical power and generalizability; (b) novelty effect: The improved performance in the FC group may be partially attributed to the novelty of the approach, which may have boosted short-term engagement; (c) self-reported motivation: Motivation data were collected using a self-report instrument (MSLQ), which is subject to bias such as social desirability and variability in self-perception; (d) dropout rate imbalance: The control group had a higher dropout rate, which could indicate lower engagement with traditional teaching and potentially skew the final comparison.

Further studies should aim to replicate these findings with larger and more diverse samples. Longitudinal designs would help assess retention of knowledge and long-term motivation. Future experiments could also explore hybrid approaches that integrate gamification or peer instruction with the FC model to further enhance engagement and learning outcomes in computer science education. Finally, it is worth highlighting that three students from the experimental group qualified for the OBI state-level phase, and one of them advanced to the national phase—an achievement that underscores the real-world impact and potential of the methodology applied in this study.

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## References


Barbosa, E. F. and de Moura, D. G. (2013). Metodologias ativas de aprendizagem na educação profissional e tecnológica. *Boletim Técnico do Senac*, 39(2):48–67.

Bergmann, J. and Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. International society for technology in education.

Berrett, D. (2012). How 'flipping'the classroom can improve the traditional lecture. *The chronicle of higher education*, 12(19):1–3.

Chen, F., Lui, A. M., and Martinelli, S. M. (2017). A systematic review of the effectiveness of flipped classrooms in medical education. *Medical Education*, 51(6):585–597.

Gontijo, C. M. M. (2015). Base nacional comum curricular (bncc): comentários críticos. *Revista Brasileira de Alfabetização*, (2).

Jiang, M., Yuen, M., and Lee, K. (2021). Does flipped classroom improve student learning in programming courses? a meta-analysis. *IEEE Access*, 9:110680–110691.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of psychology*.

Lopes, A., Santana, T., and Braga, A. (2019). Um relato de experiência sobre o ensino de programação de computadores no ensino básico por meio da olimpíada brasileira de informática. In *Anais do XXVII Workshop sobre Educação em Computação*, pages 151–160. SBC.

Martins, E. R., Gouveia, L. M. B., Afonseca, U. R., and Geraldes, W. B. (2019). Comparação entre o modelo da sala de aula invertida e o modelo tradicional no ensino de matemática na perspectiva dos aprendizes. *Experiências em Ensino de Ciências*, 14(1):522–530.

MEC (2017). Base nacional comum curricular. Disponível em: `http://basenacionalcomum.mec.gov.br`. Acesso em: 02 de julho 2022.

MEC (2018). Programa de inovação educação conectada. ministério da educação. Disponível em: `http://educacaoconectada.mec.gov.br/`. Acesso em: 02 de julho 2022.

Neo, A. V. B. d. S. et al. (2020). Estratégias de aprendizagem autorregulada com tic: análise do desempenho acadêmico de alunos do ensino superior.

Nunes, N. B., Alves, L. P., and De Bona, A. S. (2021). O pensamento computacional como base para o ensino-aprendizagem de matemática através da obmep. In *Anais do XXXII Simpósio Brasileiro de Informática na Educação*, pages 1087–1095. SBC.

OBI (2022). Olimpíada brasileira de informática. Disponível em: `https://olimpiada.ic.unicamp.br/`. Acesso em: 02 de julho 2022.

Olivindo, M., Veras, N., Viana, W., Cortés, M., and Rocha, L. (2021). Gamifying flipped classes: An experience report in software engineering remote teaching. In *Anais do XXXV Simpósio Brasileiro de Engenharia de Software*, Porto Alegre, RS, Brasil. SBC.

Pereira, I. B., Santos, J., and Suárez, P. (2019). Análise de uma aplicação gamificada para o aprendizado de matemática discreta. In *Brazilian Symposium on Computers in Education (Simpósio Brasileiro de Informática na Educação-SBIE)*, volume 30, page 636.

Pintrich, P. R. et al. (1991). A manual for the use of the motivated strategies for learning questionnaire (mslq).

Raabe, A. L. A., Brackmann, C. P., and Campos, F. R. (2018). Currículo de referência em tecnologia e computação: da educação infantil ao ensino fundamental. *Centro de Inovação para a Educação Básica-CIEB*.

Rossi, L. L., da Silva, D. P., Araujo, K. F., Pinheiro, F. J. R., Mariani, W. C., and Rosa, A. M. C. (2021). Olimpíada brasileira de informática–obi 2020. *Extensão Tecnológica: Revista de Extensão do Instituto Federal Catarinense*, 8(16):141–147.

Salvador, D. F., Rolando, L. G. R., de Oliveira, D. B., and Vasconcellos, R. F. R. R. (2017). Uso do questionário mslq na avaliação da motivação e estratégias de aprendizagem de estudantes do ensino médio de biologia, física e matemática. *Revista de Educação, Ciências e Matemática*, 7(2).

Schmitz, E. X. d. S. et al. (2016). Sala de aula invertida: uma abordagem para combinar metodologias ativas e engajar alunos no processo de ensino-aprendizagem.

Sun, J. C.-Y. and Wu, Y.-T. (2022). The effects of flipped classroom on learning motivation and learning strategies. *Educational Technology Research and Development*, 70:451–470.

Thai, N. T. T., De Wever, B., and Valcke, M. (2017). The impact of a flipped classroom design on learning performance in higher education: Looking for the best ”blend” of lectures and guiding questions with feedback. *Computers & Education*, 107:113–126.

Xavier, R. d. C. (2020). Relação entre estratégias de aprendizagem autorreguladas e prorrogação da gratificação acadêmica: um estudo relacionado com o sucesso acadêmico na área de negócios. B.S. thesis, Universidade Tecnológica Federal do Paraná.