

Teacher Feedback and Students' Prediction of Their Performance: Exploring the Relationship in Secondary Education

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Abstract

Feedback is a crucial component of educational practice because it informs students about their progress and enhances their ability to accurately predict their performance through self-regulation and metacognitive awareness. For feedback to be effective, it must be provided promptly, clearly, and include specific suggestions for improvement. This literature review, conducted according to the PRISMA 2020 methodology guidelines, analyzes 14 empirical studies from the decade 2015-2025 to investigate the impact of teacher feedback on secondary school students' ability to accurately predict their performance. The findings indicate that feedback significantly improves students' accuracy in predicting their performance, particularly when it is clear, timely, and personalized. This process strengthens their metacognitive skills and self-regulatory abilities. Individual and cognitive factors, along with self-assessment processes, play a vital role in reducing performance overestimations, especially among low-achieving students, leading them to make more realistic and accurate predictions. Additionally, socio-emotional and school-related factors enhance students' engagement in the learning process and their openness to feedback. The integration of technology and collaboration between schools and families further supports the development of student autonomy and motivation. Conversely, environmental and cultural factors—such as socioeconomic and linguistic backgrounds—affect the effectiveness of feedback and the accuracy of performance predictions. Finally, the findings emphasize the advantages of self-assessment over traditional feedback methods and highlight the necessity of incorporating digital tools to aid in making more accurate performance predictions in secondary education.

Keywords: feedback, performance prediction, secondary education

1. Introduction

Feedback is a crucial aspect of the educational process. Emphasizing its relevance to multiple factors can make educators and researchers feel that the study is comprehensive and impactful. Feedback serves as a bridge between students' current performance and their learning goals, helping them to better predict their future performance. Feedback provides valuable information about both mistakes and successes, contributing to improved learning and the development of metacognitive skills (Hattie & Timperley, 2007). Performance prediction is closely related to metacognitive theory, which suggests that students manage their cognitive functions through accurate self-assessments (Hellas et al., 2018). This is particularly important in secondary education, where the foundations of self-regulation and self-perception are established. A student's receptivity to feedback significantly influences the accuracy of their performance predictions. Self-regulation theory indicates that students with developed metacognitive abilities effectively utilize feedback to adjust their learning strategies. On the other hand, anticipation theory emphasizes the interplay of cognitive, emotional, and environmental factors in the accuracy of their assessments (Hattie, 2012). Self-assessment plays a vital role in this process. It encourages active participation and self-regulation by enabling students to identify their weaknesses and set realistic goals, which, in turn, enhances their receptiveness to external feedback (Nicol & Macfarlane-Dick, 2006). Previous research has demonstrated that formative feedback is an effective tool for enhancing learning, particularly when it is clear, timely, and personalized (Black & Wiliam, 1998). Models such as those proposed by Hattie and Timperley (2007) outline levels of implementation that contribute to maximum effectiveness. Studies on performance prediction have explored models based on cognitive abilities and the school environment, with a focus on the accuracy of metacognitive judgments in older students (Eccles, 2005). However, much of this research has concentrated on tertiary education, creating a gap in our understanding of the relationship between

feedback and performance prediction in secondary education. This paper aims to address this gap by investigating the role of feedback considering individual, cognitive, socio-emotional, family, school, and environmental-cultural factors, highlighting the complexity and importance of this topic for educational research and practice. Although the literature also includes studies using predictive analytics and machine learning models, this review focuses primarily on students' ability to predict their own academic performance. Studies employing predictive technologies were included only when teacher feedback contributed to improving students' prediction accuracy or metacognitive calibration.

2. Theoretical Framework

Feedback in education refers to the information provided to students about their performance, with the goal of improving their understanding, skills, and future achievements (Hattie & Timperley, 2007). This is especially important in secondary education, where students experience significant cognitive, emotional, and social development. During this stage, they are expected to develop complex skills such as critical thinking, self-regulation, and strategic learning. Effective feedback goes beyond simply indicating correct or incorrect answers; it also includes guidance and suggestions that promote the development of higher-order cognitive processes (Shute, 2008). For feedback to be truly effective, it must be timely, clear, personalized, and aligned with learning criteria. This enables students to assess their progress and enhances their sense of autonomy (Black & Wiliam, 1998). Quality feedback helps students better understand assessment criteria, foster self-control, boosts intrinsic motivation, and develops learning strategies that prepare them for future academic and professional challenges (Hattie & Timperley, 2007). In secondary education, feedback takes on a more diverse and complex form. It can be categorized into several types: (a) Outcome feedback, which indicates whether the work is correct or incorrect and is particularly useful for exam preparation (Hattie & Timperley, 2007), (b) Process feedback, which focuses on the strategies and steps the student used, contributing to the development of critical thinking and creativity (Shute, 2008), (c) Metacognitive feedback which encourages students to self-assess and self-regulate, helping them adjust their learning path (Nicol & Macfarlane-Dick, 2006), and (d) Reinforcement feedback, which emphasizes encouragement and confidence-building, especially important at a level where exam anxiety and social pressures can be intense (Black & Wiliam, 1998). The combination of these feedback formats enhances both academic performance and independent learning.

Self-assessment plays a crucial role in the learning process by enabling students to reflect on feedback, recognize their strengths, and identify areas for improvement. When combined with feedback, self-assessment enhances self-regulation, fosters metacognitive skills, and equips students to manage their learning more effectively. This, in turn, increases the likelihood of improvement and helps predict future performance (Hattie & Timperley, 2007). Predicting academic performance is an important aspect of educational psychology and learning because it helps identify students who may be struggling, allowing for early intervention (Nicol & Macfarlane-Dick, 2006). This is particularly critical in secondary education, where academic demands are high, and the transition to higher education is essential. Various educational data analysis methods, such as neural networks, Bayesian models, and decision trees, are used to analyze cognitive, behavioral, and social data to identify patterns linked to low performance or the risk of dropping out (Hellas et al., 2018). Research in this area does not focus solely on grades; it also examines factors such as motivation, self-regulation, and resilience (Hattie & Timperley, 2007). In this context, feedback serves as both a tool for improvement and a source of predictive data. By systematically observing how students respond to interventions, engage with instruction, and improve their performance, teachers can develop predictive models of learning (Brookhart, 2017). A student who effectively utilizes targeted feedback is likely to show ongoing improvement, while a student who does not actively incorporate corrections is less likely to do so (Van der Kleij et al., 2015). Furthermore, feedback provides insights into metacognitive skills, learning patterns, and knowledge gaps, offering a more accurate picture of future performance than simple grade analysis (Carless, 2015). When combined with self-assessment and reflection, feedback enhances students' engagement in their learning and promotes self-regulation skills (Hattie & Timperley, 2007).

Predicting performance in secondary education is a complex process influenced by many interconnected factors. At the individual level, key indicators include academic skills, memory, attention, previous school performance, and metacognitive strategies (Eccles, 2005). Additionally, motivation for learning, self-regulation, and a sense of self-efficacy play crucial roles in adolescents' ability to meet the demands of challenging programs (Bandura, 1997). In the socio-emotional domain, factors such as self-esteem and emotional regulation - including the management of anxiety, frustration, and exam pressure - are significant for school adjustment. Social skills, such as cooperation, communication, conflict resolution, and teamwork, also contribute to this adjustment. Furthermore, peer relationships, social acceptance, the influence of friends, and the ability to cope with bullying play important roles (Juvonen & Graham, 2014). The family unit is another critical predictor of performance. Its educational level, expectations, attitudes toward learning, and the support it provides can significantly impact a student's success (Eccles, 2005). Socioeconomic background and living conditions further shape learning opportunities (Juvonen & Graham, 2014). At the school level, factors such as the quality of teaching, differentiated instruction, systematic feedback, and a positive classroom climate

contribute to academic progress (Juvonen & Graham, 2014). Finally, environmental factors, including the physical and material conditions for learning, access to extracurricular activities and resources, and cultural factors—such as linguistic and ethnic backgrounds and socioeconomic inequality—significantly affect overall performance (Eccles, 2005). In this review, performance prediction is defined as students' ability to estimate and calibrate their own academic performance. Accordingly, studies using predictive technologies were included only when they examined the contribution of teacher feedback to students' self-prediction accuracy or metacognitive development.

3. Previous Research - Contribution of This Review

This review examines systematic, literature reviews and meta-analyses from the last decade (2015–2025), which include a substantial number of studies. These studies explore the impact of feedback on students' learning, performance, and motivation across various educational settings. They also take into account factors such as clarity, personalization, technology use, and students' active participation, all of which contribute to enhancing the effectiveness of feedback. One significant meta-analysis by Van der Kleij, Feskens, and Eggen (2015) focused on feedback in digital learning environments and analyzed 40 studies involving primary and secondary school students. The findings indicated a positive but moderate effect on learning performance, highlighting that analytical and explanatory feedback was more effective than simple right/wrong feedback. Additionally, Liu and Brown (2015) reviewed 44 sources, including 32 published studies and 12 doctoral theses, concerning corrective feedback in second-language writing. They pointed out that certain methodological limitations influenced the comparability of the results. Chen (2016) conducted a comparative review of 20 articles on peer feedback in English writing instruction, identifying both the advantages and challenges associated with this practice. Additionally, a meta-analysis by Dignath and Büttner (2016) examined 58 intervention studies involving primary and secondary school students. This analysis focused on programs designed to enhance metacognitive abilities and self-regulated learning. The findings revealed a significant positive effect, especially when cognitive and metacognitive strategies were combined with direct instruction.

Schneider and Preckel's (2017) systematic review analyzed 38 meta-analyses focusing on higher education students and explored the factors influencing academic performance. The findings indicated that cognitive abilities, motivation, and learning strategies have stronger positive correlations with academic success than demographic factors. Similarly, Winstone et al. (2017) conducted a study reviewing 51 research articles that emphasized learners' active participation in the feedback process. Their work highlighted the importance of understanding, implementing, and adapting feedback to meet individual student needs, which enhances its effectiveness. Additionally, a meta-analysis by Koenka and Karabenick (2018), which included 40 studies involving both secondary and tertiary students, revealed that written feedback is more beneficial for improving learning performance and motivation than grading when used alone. On the contrary, Fong et al. (2019) conducted a meta-analysis of 78 studies, finding that negative feedback can undermine students' intrinsic motivation, especially when it is perceived as a threat to their self-concept. Lastly, the systematic review by Laici and Pentucci (2019), based on 27 studies, underscored the role of digital technologies in providing feedback. Their research demonstrated that these technologies could enhance the learning process, improve teacher-student interaction, and encourage active student participation.

Haughney et al. (2020), in their review of 70 empirical studies, concluded that the effectiveness of feedback is influenced by several factors, including positivity, clarity, timeliness, and learners' active participation. Additionally, a meta-analysis by Wisniewski et al. (2020), encompassing 435 studies, confirmed the significant role of feedback in learning, particularly when it emphasizes self-regulation. At the same time, Paterson et al. (2020), through their review of 36 studies, found that students prefer feedback that is clear, timely, constructive, and closely related to their academic work. Similarly, Lipnevich and Panadero (2021), in their analysis of 14 publications, underscored the crucial role of personalization in the effectiveness of feedback. Furthermore, Frantz et al. (2022) conducted a systematic review of 11 studies, highlighting the complex interactions between non-cognitive skills and various pedagogical and learning parameters. In this context, Zynuddin et al. (2023) examined 65 articles and confirmed the relationship between school climate and the development of non-cognitive skills. Badrun (2024), analyzing 27 studies, emphasized the importance of self-assessment and peer assessment as practices that enhance student motivation. Additionally, Nieminen and Carless (2023) explored feedback literacy in higher education, highlighting the need for clearer theoretical definition and further research in this area. Finally, Cordovani et al. (2023) demonstrated that the acceptance of feedback by medical students largely depends on the quality and manner in which it is delivered. Esmaeeli et al. (2023), through their review of 25 systematic reviews, highlighted the significant contribution of feedback to the learning process and its wide range of applications in education.

A systematic review by Dönmez and Aydın (2023) examined 35 studies involving students at various educational levels to analyze the types of feedback and their effects on the learning process. The results indicated that detailed, clear, and timely feedback enhances both learning performance and student motivation, while general or vague feedback offers limited benefits. In a similar study, Fleckenstein, Liebenow, and Meyer (2023) conducted a multilevel meta-analysis

that included 20 studies focusing on secondary and tertiary students. They investigated the impact of automated writing feedback and found that such feedback can improve student performance, especially when accompanied by the instructor's guidance or explanatory comments. Concurrent to these findings, Liu (2024) performed a systematic review of 64 studies involving tertiary students, assessing the reliability and effects of automated feedback on writing. Kerman et al. (2024) discovered a link between online peer feedback and enhanced collaboration and learning but noted challenges related to feedback quality and participation levels. Similarly, Gao et al. (2024) analyzed key features of online feedback, such as structure, guidance, and quality, which influence its effectiveness. Another meta-analysis by Cen and Zheng (2024), encompassing 13 quantitative studies, showed that feedback from multiple sources can boost students' motivation in second-language writing. Additionally, Criss et al. (2025) conducted a systematic review that included 24 studies with teachers across various educational levels. Their findings emphasized the role of technology in providing feedback for teaching practices, showing that digital feedback enhances teaching quality, fosters self-reflection among teachers, and promotes their professional development. Finally, the systematic review by Brandmo and Gamlem (2025), which included 96 studies involving primary and secondary school students, confirmed that clear, explanatory, and supportive feedback boosts both learning and student engagement, whereas vague or general feedback has a limited impact.

Recent literature from the past decade on predicting student performance includes numerous systematic reviews. A study by Debray et al. (2017), which analyzed 54 studies, established guidelines for conducting systematic reviews and meta-analyses of predictive models in clinical applications. The research emphasized that transparency and consistency in presenting results enhance the reliability and generalizability of findings. Hellas et al. (2018) reviewed 357 articles published between 2010 and 2018 concerning the prediction of academic performance in Computer Science and STEM fields. They identified a wide variety of prediction techniques, primarily based on scores and average indicators. However, they noted that the quality of the study reports often appeared limited. In another review, Rastrollo-Guerrero et al. (2020) included 240 articles and demonstrated that Decision Trees, Random Forests, and Support Vector Machines (SVMs) are especially effective predictive algorithms. They also highlighted challenges related to managing heterogeneous data. Nawang et al. (2021), in their review of 40 studies from 2016 to 2020, noted that hybrid models can enhance prediction accuracy, with Random Forests and Decision Trees remaining particularly effective. Similarly, Alamri and Alharbi (2021) analyzed 54 studies from 2015 to 2020, emphasizing the importance of developing explainable and understandable predictive models to increase user confidence. Albreiki et al. (2021) reviewed 78 articles published between 2009 and 2021 that focused on high-risk students, citing limitations such as small sample sizes and incomplete assessment measures. In contrast, Khan and Ghosh (2021) found, through their analysis of 140 studies, that while predictive models tend to achieve high accuracy during classes, they are challenging to apply before classes begin. Finally, Baashar et al. (2021) analyzed 30 studies from 2015 to 2019 and identified five primary prediction methods: artificial neural networks, decision trees, SVMs, k-nearest neighbors (KNN), and Naïve Bayes. Their findings revealed that artificial neural networks exhibited the highest accuracy. The most commonly used predictors included demographic data, academic performance, family or personal characteristics, and internal assessments.

The review by Rodrigues et al. (2022) examined 24 studies conducted between 2013 and 2021 that focused on predicting student performance in primary and secondary education. The findings indicated that grades, demographics, and socioeconomic factors are key predictors of academic success. However, the authors noted limitations related to small or unbalanced sample sizes. Following this, Roslan and Chen (2022) analyzed 58 articles published between 2015 and 2021 on educational data mining, where Decision Trees emerged as the most prominent technique. In a parallel study, Chakrapani and Chitradevi (2022) reviewed 17 articles and 74 studies from 2015 to 2021, emphasizing the need to develop interpretable models to improve the confidence and effectiveness of educational interventions. In 2023, Oppong reviewed the literature and found that artificial neural networks are the most accurate classifiers for predicting academic performance. Subsequently, Al-Din and Al Abdulqader (2024) evaluated 17 reviews and 74 studies conducted from 2015 to 2023, reiterating the importance of creating interpretable prediction models. Moreover, Kumari et al. (2024) analyzed trends and data classification techniques using variables such as cumulative averages, ratings, and demographics. They identified Naïve Bayes and Decision Trees as the most frequently used methods and highlighted concerns regarding data bias and ethical considerations. Finally, Abd Rahman et al. (2024) conducted a systematic review of 51 studies using the PRISMA methodology. They noted the widespread use of methods such as Decision Trees, Linear Regression, and Artificial Neural Networks, with Artificial Neural Networks demonstrating the highest accuracy. The researchers also emphasized the need for transparency, data privacy protection, and the avoidance of bias when applying predictive models.

The literature highlights the significant role of feedback in learning, performance, and student motivation. Key factors that influence this impact include clarity, personalization, timely delivery, and active participation from students.

Various forms of feedback, including written, oral, digital, peer, and automated feedback, have been studied to explore their relationships with students' cognitive, metacognitive, and emotional development. Research aimed at predicting student performance examines models that consider factors such as skills, motivation, school climate, and technology use. However, despite the importance of feedback in learning and self-regulation, there are relatively few studies that investigate how feedback influences secondary school students' ability to accurately predict their own performance.

4. Purpose - Research Questions - Methodology

The primary aim of this paper is to conduct a literature review that examines the impact of teacher feedback on secondary school students' ability to accurately predict their performance. This study specifically explores how predictions are influenced by various factors, including individual and cognitive factors, socio-emotional factors, and family, school, and environmental-cultural factors. The analysis focuses on research published between 2015 and 2025, with the goal of drawing conclusions, identifying research gaps, and making recommendations for future studies. This literature review seeks to answer the following research questions: a) How do individual factors affect how students use feedback to predict their performance? b) To what extent do socio-emotional factors influence the process by which feedback helps students accurately predict their work performance? c) How are family and school factors related to students' usage of feedback in predicting their performance? d) What impact do environmental and cultural factors have on the relationship between feedback and students' performance predictions? e) To what extent are self-assessment tools and procedures used to support secondary school students in effectively utilizing feedback and improving their performance prediction abilities? f) How does the effectiveness of feedback, in terms of students' ability to accurately predict their performance, differ between environments that use self-assessment tools and those that do not? Additionally, the review analyzes the fields of study, sample characteristics and sizes, types of data collected, and the research tools utilized. The methodology of this review follows the PRISMA 2020 statement by Page et al. (2021), which provides guidelines for the stages of study identification, screening, suitability assessment, and final selection (see Figure 1).

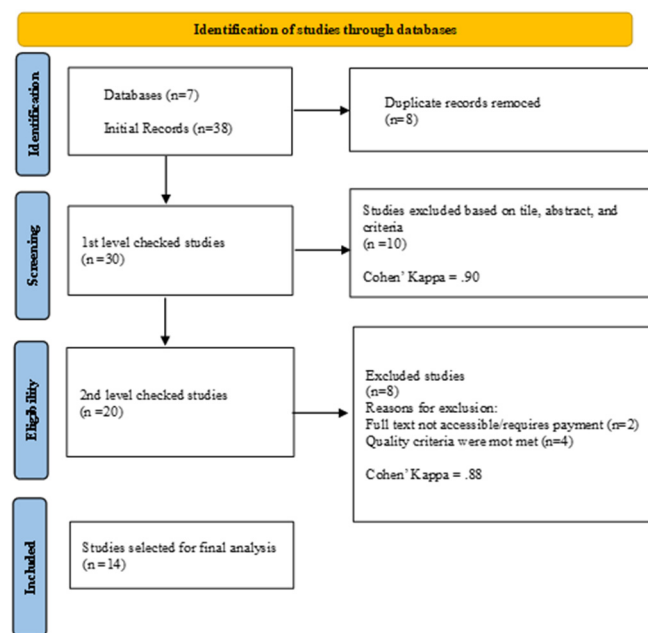


Figure 1. Flowchart of the literature review based on the PRISMA 2020 guidelines (Page et al., 2021)

The search strategy was based on combinations of the following keywords and search strings: ("Feedback" AND "students' performance prediction" AND "students*" AND "instructors*" AND "secondary education*"). Additional research was conducted by replacing specific terms with related alternatives, including "learners*" instead of "students*", "teachers*" instead of "instructors*", and variations of the educational level terms, such as "secondary school*", "senior school*", and "high school*". Furthermore, searches were conducted to identify factors influencing students' ability to predict their academic performance, including individual cognitive, socio-emotional, family, school, and environmental-cultural factors. Specific search combinations, such as ("self-assessment" AND "feedback" AND "secondary education"), were also used to explore the relationship between self-assessment, self-regulation, and the accuracy of students' performance predictions.

The literature search was conducted using seven electronic sources between October and December 2025. Scopus and IEEE Xplore were selected due to their broad coverage of scientific literature, while ScienceDirect, SpringerLink, and SAGE Journals were included to capture research from the social sciences, education, and related fields. In addition, ResearchGate and Google Scholar were used as supplementary sources to identify additional relevant publications. This process yielded a total of 40 studies, from which 8 duplicates were excluded, leaving 30 studies for the initial review. During the first-level review, titles and abstracts were assessed based on predefined criteria: a) language (English or Greek), b) relevance to education, c) reference to feedback and prediction of performance in secondary education, d) information available in the abstract, and e) publication date within the years 2015–2025. Two reviewers independently screened all records, and inter-rater reliability was assessed using Cohen's kappa coefficient, indicating substantial agreement during the title and abstract screening stage ($\kappa = 0.80$). Out of the 30 studies reviewed, 10 were excluded, and the remaining 20 advanced to a second review. During this stage, 2 studies were excluded due to payment requirements. The final assessment involved evaluating the quality of the remaining 18 studies based on three key aspects: a) the context of the effect of feedback on performance predictions by secondary education students (including cognitive field and research type), b) the methodological design (data type and sample), and c) the data collection methods and tools used. Ultimately, 14 studies that met the criteria for the literature review were selected. Inter-rater reliability for the full-text assessment was also evaluated using Cohen's kappa coefficient, indicating almost perfect agreement between the two reviewers ($\kappa = 0.89$). Any disagreements at both stages were resolved through discussion and consensus (Figure 1).

5. Results

The following tables present studies that examine the relationship between feedback and secondary school students' ability to accurately predict their performance. The data includes details such as the researchers, year, country, purpose, research type, sample, subject area, and findings. This information is organized based on several factors: a) individual and cognitive, b) socio-emotional, c) family, d) school, e) environmental, and f) cultural influences. Specifically, Table 1 showcases the results regarding the impact of feedback on students' accuracy in predicting their performance. This table focuses on factors related to individual student characteristics, including academic skills, memory, attention, previous school performance, metacognitive strategies, motivation and interest in learning, self-regulation, and self-efficacy, addressing the first research question.

Table 1. Results of feedback's effect on accurately predicting student performance in secondary education, considering cognitive factors and individual student characteristics

Researchers Year Country	Purpose of research	Research Type Sample Size Subject	Results
Galyardt & Goldin 2015 USA	Development of the R-PFA model to predict performance during tutoring, with an emphasis on recent successes and failures.	Quantitative 4,138 students Middle school/High school General education Assistments platform, R-PFA model	The R-PFA model demonstrates significantly improved predictive accuracy compared to existing and new baseline models on both real and synthetic data.
Raaijmakers, Baars & Paas 2019 Netherlands	This study investigates whether receiving feedback on self-assessment enhances the accuracy of individuals following training in self-regulated learning.	Experimental 108 students (49 males, 59 females) Middle school General education Self-assessment Video modeling, learning and testing phases	There was no improvement in the accuracy of self-assessments. Furthermore, general feedback resulted in decreased accuracy.
Yeiri & Avramovich 2023 Israel	Exploring whether children with low comprehension benefit from practicing anticipating comprehension questions, with or without feedback, to enhance response accuracy and monitoring.	Experimental 88 students High school Language, comprehension Self-assessment (confidence ratings in answers)	Practice and feedback enhanced accuracy on literal questions. Comprehension improved only for good comprehenders, while poor comprehenders struggled with processing and monitoring.
Ober, Cheng, Carter & Liu 2023 USA	Uses performance indicators and feedback from a digital learning platform to predict student educational outcomes early.	Experimental 726 students High School 295 boys, 435 girls) Mathematics, Statistics Self-assessment (Digital learning platform Moodle)	Indicators related to performance and feedback-seeking behavior on a digital learning platform can effectively predict educational outcomes.
Kubsch, Grimm, Strauß, Gombert, Drachsler, Neumann & Rummel 2025 Germany	Studies the role of cognitive, affective, and metacognitive factors in self-regulation in predicting learning productivity to develop an early warning system.	Experimental 214 students Middle School Physical Sciences Self-assessment Digital workbooks via Moodle	The integration of cognitive, affective, and metacognitive factors is a predictor of productivity and performance.
Ukaj & Reshani 2025 Bosnia and Herzegovina	Examining how motivation and engagement affect feedback and academic success.	Quantitative (questionnaires) 327 students High school General education	Feedback influences motivation and engagement and helps predict academic success.

Table 2 presents the results regarding the relationship between feedback and students' accurate predictions of their performance. This analysis is based on socio-emotional factors such as self-esteem and emotional regulation, which includes managing anxiety, frustration, and exam pressure. Additionally, it considers social skills like collaboration, communication, conflict resolution, teamwork, and interpersonal relationships, including social acceptance, peer influence, and coping with bullying. This information addresses the second research question.

Table 2. Results showing the effect of feedback on accurately predicting students' performance in primary education, considering socio-emotional factors

Researchers Year Country	Purpose of research	Research Type Sample Size Subject	Results
Kyaruzi, Stribos, Ufer & Brown 2019 Tanzania	Investigates how students' views on teachers' formative assessment methods and feedback impact their use of that feedback and their performance predictions.	Quantitative 2,767 students Mathematics Self-assessment (self-report questionnaires)	Students' perceptions of formative assessments and feedback influenced their usage, which consequently affected their performance.
Kubsch, Strauß, Grimm, Gombert, Drachsler, Neumann, & Rummel 2025 Germany	Studies the role of cognitive, affective, and metacognitive factors in self-regulation in predicting learning productivity to develop an early warning system.	Experimental 214 students Middle School Physical Sciences Self-assessment Digital workbooks via Moodle	The integration of cognitive, affective, and metacognitive factors is a predictor of productivity and performance.
Ukaj & Reshani 2025 Bosnia and Herzegovina	Examining how motivation and engagement affect feedback and academic success.	Quantitative (questionnaires) 327 students High school General education	Feedback influences motivation and engagement and helps predict academic success.

It is important to note that no research has been found regarding the impact of feedback on students' accurate predictions of their performance in relation to family factors, such as educational level, expectations, attitude towards learning, support provided, socioeconomic background, and living conditions (3rd research question). Table 3 presents the results regarding the effect of feedback on students' accurate predictions of their performance based on school factors, including the quality of teaching, differentiation of learning, and a positive classroom climate (3rd research question).

Table 3. Results of how feedback affects the accurate prediction of students' performance in primary education based on school factors

Researchers Year Country	Purpose of research	Research Type Sample Size Subject	Results
Galyardt & Goldin 2015 USA	Development of the R-PFA model to predict performance during tutoring with an emphasis on recent successes and failures.	Quantitative 4,138 students Middle school/High school General education Assistments platform, R-PFA model	The R-PFA model demonstrates significantly improved predictive accuracy compared to existing and new baseline models on both real and synthetic data.
Roschelle, Feng, Murphy & Mason 2016 USA	Evaluating the impact of an educational intervention combined with teacher training on improving mathematics learning through assignments.	Experimental 2,850 students High school Mathematics ASSISTments (online assignment tool)	The intervention led to a significant increase in scores, particularly benefiting students who had low performance prior to the program.
Fateen & Mine 2021 Japan	Suggests a method for predicting student performance on entrance exams by using teacher observation reports to guide students and improve educational outcomes.	Quantitative 159 students High School General education (machine learning, Natural Language Processing techniques)	When teacher information was integrated with other data sources, the predictions became more accurate and precise.
Yeiri & Avramovich 2023 Israel	Exploring whether children with low comprehension benefit from practicing and anticipating comprehension questions, with or without feedback, to enhance response accuracy and monitoring.	Experimental 88 students High school Language, Text comprehension Self-assessment (confidence ratings in answers)	Practice and feedback enhanced accuracy on literal questions. Comprehension improved only for good comprehenders, while poor comprehenders struggled with processing and monitoring.
Wang, Gao & Ye 2024 China	Development and evaluation of a data-driven intervention system to improve learning effectiveness through personalized learning.	Experimental 142 students High school Mathematics, Science Online learning platform	The precision intervention significantly improved academic performance and learning engagement, with very high predictive accuracy in some cases, depending on the model and data.

Table 4 displays the results regarding the impact of feedback on students' ability to accurately predict their performance. This prediction is influenced by environmental factors, including physical and material learning conditions, access to extracurricular activities, and available resources. Additionally, cultural factors such as linguistic and ethnic backgrounds, as well as socioeconomic inequality, are also considered in relation to the fourth research question.

Elements related to the fifth and sixth research questions—specifically, the extent to which self-assessment procedures and tools are used, as well as their impact on students' ability to accurately predict their performance—are included in all tables that present the results. These aspects will be analyzed in detail in the subsequent discussion of the results.

Table 4. Results showing the effect of feedback on accurately predicting students' performance in primary education, considering environmental factors

Researchers Year Country	Purpose of research	Research Type Sample Size Subject	Results
Roschelle, Murphy & Mason 2016 USA	Evaluating the impact of an educational intervention combined with teacher training on improving mathematics learning through assignments.	Experimental 2,850 students High school Mathematics ASSISTments (online assignment tool)	The intervention led to a significant increase in scores, particularly benefiting students who had low performance prior to the program.
Khan, Khan, Imran, Khan & Ahmed 2022 Pakistan	The study presents a model that accurately predicts student performance while utilizing data with low processing time and minimal memory requirements.	Experimental 50 students High school General education Google Forms	The proposed model predicts student performance with very high accuracy. The dataset used has many dependent variables and requires less processing time.
Wang, Gao & Ye 2024 China	Development and evaluation of a data-driven intervention system to improve learning effectiveness through personalized learning.	Experimental 142 students High school Mathematics, Science Online learning platform	Precision intervention significantly improved academic performance and learning engagement, with very high predictive accuracy in some cases, depending on the model and data.
Ober, Cheng, Carter & Liu 2023 USA	Uses performance indicators and feedback from a digital learning platform to predict student educational outcomes early.	Experimental 726 students High School 295 boys, 435 girls) Mathematics, Statistics Self-assessment (Digital learning platform Moodle)	Indicators related to performance and feedback-seeking behavior on a digital learning platform can effectively predict educational outcomes.
Masrul & Wicaksono 2024 Indonesia	Examining the impact of corrective feedback on students' writing performance	Mixed (experimental, quantitative) 96 students (30 males, 66 females) English as a second language High school pre- and post-test, revisions	Consistent corrective feedback greatly enhances writing performance, improves language skills, and predicts academic success.
Lu, Griffin, Sadler, Laffey & Goggins 2025 USA	Building a predictive model for learning through games to implement valid assessment.	Quantitative 806 students High school Educational technology Games, machine learning algorithms	The predictive model improves assessment accuracy, enhancing understanding of learning progress through games.
Santoso, Kurniawan, Wahyudi, Bahri, Fathurrahman & Syahbrudin 2025 Indonesia	Offering a dataset for applying machine learning techniques to predict student performance based on context and results.	Quantitative 497 students High School Science (assessment tools, Google Forms)	Machine learning can improve accuracy in predicting performance, aiding early intervention and differentiated instruction.

6. Discussion

This literature review examined 14 empirical studies, none of which were published in conference proceedings. In terms of time distribution, the majority of the studies were conducted in 2025 (n=4), while two studies were reported in 2019, 2023, and 2024. Fewer studies were identified for the years 2015, 2016, 2021, and 2022, with one study each for those years. It is noteworthy that no studies were found from 2017, 2018, or 2020. Geographically, most studies originated from Asia (n=6, 42.9%) and America (n=4, 28.6%), followed by Europe (n=3, 21.4%) and Africa (n=1, 7.1%). The United States recorded the highest number of studies (n=4, 28.6%), followed by Indonesia (n=2, 14.3%). Additionally, there was one study each from Pakistan, China, the Netherlands, Germany, Israel, Tanzania, Japan, and Bosnia and Herzegovina. Regarding study types, experimental (n=7, 50.0%) and quantitative (n=6, 42.9%) methods were the most

common, while mixed methods ($n=1$, 7.1%) were much less frequent, and no qualitative methods were present. The sample sizes varied significantly across studies. The majority included samples ranging from 101 to 500 participants ($n=6$, 42.9%), and samples over 500 participants ($n=5$, 35.7%). In contrast, two studies included 51–100 participants ($n=2$, 14.2%), while only one study had a sample size of 11 to 50 participants ($n=1$, 7.1%). Overall, participant numbers ranged from 50 to 4,138. Specifically, in quantitative studies, the sample size ranged from 159 to 4,138 people, while experimental studies had samples ranging from 50 to 2,850, and the mixed-method study had a sample size of 96 participants. It is important to note that only three studies (21.4%) reported the male-to-female ratio. In terms of secondary education, most studies were conducted in high schools ($n=11$, 78.6%), followed by middle schools ($n=2$, 14.2%). One study combined middle and high schools. Concerning the subjects covered, general education, which encompasses all subjects, was the most prominent, with five studies (35.7%). This was followed by Mathematics and Natural Sciences, each with two studies. Additionally, three studies focused on Language, Educational Technology, and English as a second language. Two studies also combined subjects in Mathematics-Statistics and Mathematics-Natural Sciences, respectively. Lastly, the use of digital media was identified in 10 out of the 15 studies (71.4%). literature

The influence of individual and cognitive factors, addressed in the first research question, shows a strong consensus across the seven studies included in this review: feedback improves the accuracy of performance predictions. Specifically, experimental studies focused on calibration and self-assessment (Raaijmakers et al., 2019; Ober et al., 2023; Yeari & Avramovich, 2023; Kubsch et al., 2025) align with large-scale quantitative studies (Galyardt & Goldin, 2015; Ober et al., 2023; Ukaj & Reshani, 2025) in demonstrating that the effectiveness of feedback is enhanced when it is combined with developed metacognitive skills, self-regulatory processes, and prior performance as reference points. This agreement is consistent with both classical and contemporary feedback models, which suggest that the quality of feedback influences the activation of students' cognitive and metacognitive processes (Black & Wiliam, 1998; Nicol & Macfarlane-Dick, 2006). Furthermore, all studies concur that students who exhibit higher levels of intrinsic motivation and developed metacognitive awareness tend to overestimate their abilities less and demonstrate greater accuracy in self-evaluations. This finding aligns with prior empirical studies indicating that intrinsic motivation and effective learning strategies are key predictors of performance (Hattie & Timperley, 2007; Brookhart, 2017). Additionally, there is a clear convergence regarding the role of prior performance and existing knowledge. Students with lower performance or inadequate metacognitive accuracy often show a stronger tendency to overestimate their abilities, particularly in complex subjects (Galyardt & Goldin, 2015; Raaijmakers et al., 2019; Yeari & Avramovich, 2023; Ober et al., 2023). This trend is confirmed by previous research (Papamitsiou & Economides, 2014; Van der Kleij et al., 2015). Finally, studies utilizing digital interventions reveal common results, indicating that educational platforms and automated systems enhance metacognitive knowledge, motivation, and accuracy in performance prediction, especially in subjects such as mathematics, statistics, and text comprehension (Galyardt & Goldin, 2015; Ober et al., 2023; Kubsch et al., 2025). The consistent alignment of these findings supports the view that formative feedback - whether traditional or technology-assisted - is a robust mechanism for promoting self-regulated learning in secondary education (Hattie & Timperley, 2007). Despite these converging findings, further research is needed on differentiated feedback, its relationship with individual and cognitive factors, and its long-term effects on prediction accuracy.

Regarding socio-emotional factors (research question 2), the three studies reviewed indicate that feedback significantly enhances student engagement in the learning process and serves as a crucial predictor of academic performance. Specifically, it was found that students' perceptions of formative assessment practices and feedback affect how they utilize feedback, which in turn influences their academic performance (Kyaruzi et al., 2019). Moreover, integrating cognitive, affective, and metacognitive self-regulation factors into digital learning environments can help predict learning productivity and future performance (Kubsch et al., 2025). Feedback also seems to boost learning motivation and engagement (Ukaj & Reshani, 2025). These findings align with international literature, which emphasizes the substantial impact of qualitative feedback on learning motivation and student participation, especially when such feedback offers clear directions for improvement (Koenka & Karabenick, 2018; Wisniewski et al., 2020). Furthermore, students' perceptions and active use of feedback are critical in enhancing learning engagement and academic success (Brandmo & Gamlem, 2025; Winstone et al., 2017; Fong et al., 2019; Cen & Zheng, 2024).

In examining the impact of feedback on accurately predicting student performance, particularly in relation to family factors such as parental education, expectations, and support, this review found no relevant studies addressing this third research question. However, at the school level, five studies investigated the role of feedback and educational interventions in predicting learning outcomes. The findings suggest that combining feedback with digital tools and data analysis models can significantly enhance the accuracy of performance predictions. Notably, the R-PFA model shows higher predictive accuracy compared to other models (Galyardt & Goldin, 2015). Additionally, interventions using the ASSISTments platform have resulted in significant improvements in students' mathematical performance (Roschelle et al., 2016). Furthermore, leveraging data from teachers and learning activities can further increase the accuracy of

performance predictions (Fateen & Mine, 2021). Providing feedback and opportunities for practice has also been shown to improve response accuracy and text comprehension (Yeari & Avramovich, 2023). Moreover, personalized learning interventions delivered through online platforms can enhance both academic performance and student engagement (Wang, Gao & Ye, 2024). Nonetheless, the absence of research focusing on family factors highlights the need for further investigation into variables such as parental education level, the family learning environment, and the support provided at home.

The findings related to environmental and cultural factors (research question 4) suggest that utilizing digital platforms and learning data can significantly enhance the prediction of student learning performance. Eight studies reviewed examined how these factors influence learning outcomes. For example, interventions that use the ASSISTments platform have been shown to significantly improve students' mathematics performance (Roschelle et al., 2016). Additionally, predictive models based on educational data can accurately forecast student performance (Khan et al., 2022). Furthermore, monitoring performance and seeking feedback in digital learning environments are linked to better learning outcomes and can help predict performance early (Ober et al., 2023). Personalized learning interventions implemented through online platforms can also lead to significant improvements in academic performance and learning engagement (Wang, Gao & Ye, 2024). Moreover, providing corrective feedback and employing machine learning techniques can enhance learning progress and yield more accurate predictions of student performance (Masrul & Wicaksono, 2024; Lu et al., 2025; Santoso et al., 2025). Despite these significant findings, research into environmental and cultural factors remains limited. Future studies should systematically explore the influence of variables such as students' socioeconomic and linguistic backgrounds, as well as their access to educational and technological resources across various educational contexts.

In relation to the degree of utilization of self-assessment processes and tools (the fifth research question), the findings indicate that self-assessment is increasingly recognized as a vital tool for supporting learning and utilizing feedback. The studies included in this review demonstrate various implementations of self-assessment, utilizing different tools and processes. Specifically, practices for students to judge their own confidence and monitor their comprehension (Yeari & Avramovich, 2023), as well as digital learning platforms and learning management systems, were employed to track student progress and provide feedback (Ober et al., 2023; Kubsch et al., 2025). Additionally, self-report tools like questionnaires were used to explore students' perceptions of formative assessment and feedback (Kyaruzi et al., 2019). Other methods included modeling videos and phases for learning and testing (Raaijmakers et al., 2019).

Finally, regarding the effectiveness of self-assessment in utilizing feedback and improving the accuracy of performance predictions (research question 6), the review's findings indicate that self-assessment practices can enhance the monitoring of learning progress and foster the development of self-regulated learning skills (Kubsch et al., 2025; Kyaruzi et al., 2019). Through systematic self-assessment, students can identify their strengths and weaknesses, which enables them to adapt their learning strategies based on the feedback they receive (Yeari & Avramovich, 2023; Ober et al., 2023). In contrast, studies focusing primarily on performance monitoring or feedback seeking—rather than self-assessment—suggest that performance improvement is more closely related to how frequently students access performance information or digital learning data. However, this does not necessarily lead to greater accuracy in self-assessing their performance (Ober et al., 2023). Furthermore, some findings indicate that the effectiveness of self-assessment heavily relies on how feedback is implemented. In some cases, general feedback does not enhance the accuracy of students' self-assessments (Raaijmakers et al., 2019).

7. Conclusions – Suggestions

This literature review indicates that research on the relationship between feedback, self-assessment, and students' ability to accurately predict their performance in secondary education has increased significantly in recent years, particularly in 2024 and 2025. There is a notable concentration of research in Asia and the Americas, with the United States leading in the volume of publications. Most studies utilize quantitative or experimental methods and involve relatively large sample sizes; however, there is limited reference to demographic distributions, such as gender ratios. Moreover, the research predominantly focuses on middle and high schools, concentrating on general education as well as Mathematics and Science. There is a limited application of mixed methods and no use of qualitative methods, highlighting a potential need for a broader range of methodologies and more extensive dissemination of findings. Research also demonstrates a high use of digital media, categorized into educational platforms, automated systems, and data analysis models. This suggests that technology is actively integrated into the educational process, especially in subjects like Mathematics, Statistics, and text comprehension.

Research has shown that individual and cognitive factors play a crucial role in how students utilize feedback to accurately predict their performance. Students who possess strong metacognitive skills, intrinsic motivation, and a record of positive performance are more responsive to feedback, which helps them to reduce the likelihood of

overestimating their abilities. This, in turn, enhances the accuracy of their predictions, particularly in complex subjects. Furthermore, the combination of self-assessment, reflective practice, and digital tools contributes to improved metacognitive knowledge and self-regulation. As a result, the ability to predict performance accurately is directly linked to the development of both cognitive and metacognitive skills, as well as students' capacity to interpret and creatively apply the feedback they receive.

Socio-emotional factors—such as learning motivation, engagement, and self-concept—play a significant role in shaping students' relationships with feedback. Research has shown that formative feedback can enhance both participation and motivation. Additionally, incorporating emotional and metacognitive factors in digital environments leads to better predictions of student performance. Furthermore, studies indicate that having a positive perception of feedback improves accuracy in predicting outcomes and adapting to learning demands. Therefore, emotional regulation and trust in feedback are essential for effectively utilizing it.

Family and school factors play a crucial role in how students utilize feedback to anticipate their performance. Research indicates that combining high-quality feedback with digital tools and predictive models enhances accuracy, while personalized learning improves both performance and engagement. Despite this, there is a noticeable lack of research on family factors, particularly parental education, highlighting the need to explore their influence. Ultimately, coordinated efforts among schools and teachers serve as a catalyst for more accurate predictions of student performance.

The analysis of various studies shows that environmental and cultural factors, such as access to digital platforms and learning data, significantly influence the effectiveness of feedback and predictions. The findings suggest that technology can enhance performance and accuracy, particularly through the use of automated systems and machine learning. Additionally, some research has underscored the importance of cultural values and pedagogical norms in shaping attitudes toward feedback. Therefore, effective utilization of feedback requires adaptation to the sociocultural characteristics of the student population.

The use of self-assessment processes and tools in secondary education has been documented in several studies, indicating a high level of their application. The tools commonly used include confidence assessments, digital platforms, self-report questionnaires, and video modeling. Both digital and traditional self-assessment methods are consistently linked to improved self-regulation, enhanced metacognitive accuracy, and greater receptiveness to feedback. Therefore, systematically applying self-assessment is essential for developing predictive abilities in students.

The study's findings indicate that integrating self-assessment into learning processes offers numerous benefits for students. These benefits include improved accuracy in predicting performance, enhanced self-regulation, the development of metacognitive skills, increased motivation and engagement, and better learning outcomes, especially when connected to digital environments and students' prior knowledge. Additionally, the use of platforms and feedback further amplifies these advantages by promoting understanding and adaptability. In contrast, research that relies solely on external feedback methods limits students' autonomy, metacognition, and their ability to adapt internally, highlighting the crucial role of self-assessment as an essential learning tool.

Further research is needed to optimize feedback strategies in secondary education, focusing on the type, timing, personalization, and format of feedback, as well as its interaction with individual factors (such as intrinsic motivation and metacognitive accuracy) and socio-cultural factors (like background and access to technology). This research should particularly assess the long-term impact on performance prediction accuracy, the teacher-student relationship, and the reduction of inequalities through the use of digital tools. Special attention should be given to investigating family influences, the long-term effect on various subjects, teacher training, and how tailored interventions and digital tools can help reduce educational inequalities. The findings should support evidence-based national policies and practices that enhance self-regulation, improve metacognitive accuracy, and promote overall learning success.

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