Students Motivation to Learn Programming: A Systematic Review

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Abstract*—Contribution: This research full paper, using a systematic review, explores factors that motivate students to learn programming. This synthesized literature explains students' motivation, which will help refine educational approaches. Background: In today's technological innovation landscape, learning to program is a fundamental skill and no longer bounded by discipline or majors at college. Students need to have foundational knowledge in at least one programming language. To thrive in this digital era, it is crucial for educational institutions to not only teach computer literacy but also inspire a genuine passion for programming among students. However, what effectively motivates students for such endeavors is a challenge, especially in conceptually hard concepts of programming courses. To address the challenge, it is important to synthesize what has already been done and how instructors have nurtured their students' interests. Research Question: The research question that guides the study is: What factors motivate students to learn programming? Methodology: To uncover these factors, we collected data from two databases, ACM Digital Library and Education Source, and found one hundred and thirty-four (134) studies. We filtered one hundred and eight (108) studies using the inclusion and exclusion criteria. This systematic review presents the analysis conducted using twenty-six (26) studies. We used qualitative content analysis to identify the factors influencing students' motivation. Findings: We categorized the studies into three themes: intrinsic motivation, extrinsic motivation, and social cognition. This full paper provides an understanding of each theme and the results of the studies to explain the factors of students' motivation when learning programming. We believe that this synthesized literature will help educators refine their educational approaches to nurture and keep students motivated in programming courses.

***Keywords*—student motivation, systematic review, programming, learning**

I. INTRODUCTION

Today's rapidly advancing world is marked by pervasive innovations and technologies mainly centered around computers [1]. With this growing advancement, more than ever before, students need to pay closer attention to computing skills. [2]. Like reading and writing, computing, especially programming skills, have become vital for everyone, regardless of their college degree [3], [4]. Most colleges and schools now emphasize that each student must learn at least one programming language as a core component of the curriculum [5]. While essential for students' growth, Programming is generally conceptually hard for all students [6]. Such changes in making programming a fundamental concept regardless of major has made a new challenge evident. How do we keep students motivated in their programming courses? And especially what works for them while learning programming.

Due to the significant challenge of learning to program [7], understanding students' motivation and the factors that influence this motivation is vital for students' growth [8]. Prior studies indicate that students' motivation is a key lens to understanding students' desire to participate in the learning process [9]. For example, studies suggest that motivated students are more engaged in the learning process, which leads to better understanding and retention of programming concepts [10], [11]. Additionally, programming often involves learning complex syntax and logic building. Motivated students are likelier to persist in problem-solving and overcome learning syntax [12]. Also, motivation has an impact on performance [13]. Students motivated to learn programming tend to perform better in assessments and demonstrate higher levels of understanding. Motivation transforms a potentially frustrating experience into an exciting and rewarding learning experience [14].

The literature suggests that sources of motivation are an important aspect of understanding students' motivation [9]. Understanding these sources will provide the different factors that students consider. Also, these sources offer reasons for students. While previous research has explored various reasons or factors that motivate students, these studies often used single or few factors [15], [16], [17].

Considering the availability of literature on these factors, this study aims to synthesize the findings from existing studies to identify the factors that motivate students to learn programming. By synthesizing this information, we aim to list motivational factors. More specifically, the following research question guided this study:

What factors motivate students to learn programming?

Understanding student motivation, especially when learning programming, is critical because it directly influences their engagement, perseverance, and better performance [11].

We believe that synthesizing information on "what" factors motivate students can provide effective mechanisms to researchers and instructors for future studies and courses.

II. LITERATURE REVIEW

Programming skills have been recognized as one of the skills of the 21st Century because of the digital revolution [4]. Hence, teaching students foundational programming and computing knowledge is no longer a luxury but a necessity [18].

Motivation influences the students' efforts and persistence in learning [19]. Understanding the essential role of motivation in student learning, particularly in the context of programming education, is critical [20]. When motivated, students are more likely to participate in learning activities actively, seek challenges, and persist [21], [22].

Multiple researchers have studied motivation in the context of student learning [23], [24]. For example, using quantitative analysis, Oprea et al. analyzed motivation and school learning [25]. The study results have shown that teachers motivating students results in better learning. In another study, Ronnie et al., using qualitative analysis, highlighted that motivated students learned better than students not motivated [26].

On the other hand, researchers have pointed out the consequences faced by students who are not motivated. Students who lack motivation struggle to engage in their classes [27]. This lack of motivation towards the course also resulted in their lack of desire to get good grades [28]. These students lack persistence, which causes them to give up easily when faced with difficult tasks [29]. Abdelhamid et al. highlighted that engineering students lacking motivation have higher chances of dropping out of their programs [30].

Instructors need to know what motivates their students. When instructors comprehend what drives their students to learn, they can align their strategies accordingly [31]. In the context of learning and teaching programming, educational institutes are already modifying their curriculums by integrating computer literacy and information and communication technology (ICT) to motivate their students [32], [33]. There is a good chunk of literature available that offers valuable understandings regarding 1) using different instructional methods to improve programming education [34], [35], [36] and 2) enhancing students' motivation to learn programming [37], [38].

Scholars have explored different instructional methods that enhanced students' motivation to learn programming, e.g., peer programming [39] and problem-solving-focused lecturing [40], and worked out examples with labeled subgoals [41], [42]. Additionally, researchers have explored factors that influenced student learners in their programming learning, such as self-efficacy beliefs [43], clear directions, and reward and recognition [44].

III. RESEARCH METHODS

This study used the systematic literature review methodology to search, review, and analyze the existing literature. This review was based on the methods outlined in Borrego et al. [45] and Anwar et al.'s [46] paper on systematic literature reviews in engineering education.

A. Search Method

1) Databases and their reasoning: To explore the relevant literature, we searched in two databases: 1) Education Source – due to its coverage of educational literature across various disciplines, and 2) ACM Digital Library – due to its focus on computing and technology work. The words' motivation' and 'aspiration' are frequently used interchangeably in many studies, so we included them in our search string with a binary operator OR [47]. The search was performed twice in February 2023 using the protocol listed in Table 1.

2) Search strategy and numbers of papers found in each database: Using the search query in Table 1 for ACM and Education Source, two databases generated 106 and 28 studies, respectively. Overall, we found 134 studies.

TABLE 1. SEARCH PROTOCOL

Databases	**Search Protocol**
ACM Digital Library and Education Source	Search Query: ("Students interest" OR "student interest" OR "Student motivation" OR "student aspiration") AND ("learn*" OR "study*" OR "gaining knowledge") AND ("programming" OR "OOPS" OR "OOP" OR "Object Oriented Programming" OR "coding") AND ("undergrad*" OR "Post Secondary") Search: Advance Search Searched in: ACM Full-Text Collection

B. Selection Strategy

These 134 studies were examined in this systematic literature review based on our inclusion (Table 2) and exclusion criteria (Table 3). Inclusion and Exclusion Criteria: The final query (refer to Table 1) is used to get the available literature after tuning the search query in various iterations. However, we retrieved many papers unsuitable for this systematic review. We need an exclusion criterion for removing those studies from analysis to prevent researcher's self-bias. The exclusion criteria we used removed studies revolving around some advanced programming courses, including web programming [48], data structures [49], mobile application development [50], game development [51], embedded systems programming [52], assembly language programming [53], and cybersecurity [54]. Some studies were removed because they focused on either K-12 [55] or graduate students [56]. Many articles were removed because of their irrelevant nature [57], [58], [59], [60]. A few articles were excluded because they focused on non-computing majors [61], [62].

TABLE 2. INCLUSION CRITERIA

Inclusion Principle	**Description**
Full text	Articles available in full text rather than just abstracts were picked for this systematic review.
English Language	Articles written in English are included in this review.
Undergraduate	Articles presenting primary participants, i.e., undergraduate students, were picked.
Addresses relevant issues	Articles that focused on the student's motivation to take programming courses were picked.

TABLE 3. EXCLUSION CRITERIA

Exclusion Principle	**Description**
Advance Computing Courses	Articles in this category didn't focus on basic programming but on data structures, web programming, android application development, assembly language programming, or embedded systems programming.
K12/Graduate Students/ Non-Computing Background Participants	Articles in this category did not present primary participants, i.e., undergraduate students, but rather either present school kids or graduate students.
Irrelevant Nature of Articles	Articles in this category focused on teaching pedagogies, student reflections, curriculum innovation, and gender differences.

C. Screening

Initially, we identified the duplicate studies and removed the 07 studies. From the remaining 127, we found 66 studies irrelevant by screening their titles and abstracts. These articles were related to learning/teaching programming but did not focus on the student's motivation or aspirations. After screening the text in Title/Abstract, we had 61 studies for full-text review. We excluded 35 articles based on five exclusion principles while performing the full-text review. The exclusion criteria we used are depicted in Table 3. These exclusion principles are irrelevant nature of articles (17), studied advanced programming subjects (07), participants were either K-12 or graduate students (5), non-computing background (4), and microcontrollers assembly programming (2). The remaining 26 studies were thoroughly examined to bring the answers to our research question. Figure 1 describes the flow of information in terms of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) diagram [63].

D. Data Analysis Procedure

We used the content analysis approach for this systematic literature review. This approach helps us to systematically analyze and interpret the content to identify themes and patterns within the extensive body of literature [64], [65].

Our initial step involved documenting and characterizing each study based on these five features: 1) experimental vs. non-experimental, 2) formal vs. informal learning environments, 3) number of participants, and 4) whether the investigation specifically addressed gender. The information is also referred to in Table 4. Subsequently, our analysis investigated the shared characteristics and patterns of these 26 studies' results and findings. We classified articles based on common themes. The three common themes are: 1) intrinsic motivation, 2) extrinsic motivation, and 3) social cognition. Notably, while many articles aligned with a single theme, one study could be classified into more than one theme.

Our process included compiling primary studies into Excel sheets and developing clusters based on shared characteristics. We then added a brief description of each cluster. This description is then used to classify each study to the corresponding theme. This meticulous analysis of 26 articles facilitated the extraction of meaningful findings.

TABLE 4. DIFFERENTIATION OF REVIEWED ARTICLES

Differentiation Type	**Classification**		
Study Design	***Non-Experimental*** 15	***Quasi-Experimental*** 07	***Experimental*** 04
Learning Environment	***Formal*** 19	***Informal*** 03	***Online*** 03
No of Participants	***> 50*** 12	***< 50*** 04	***Not mentioned*** 10
Gender Focused	***Male*** 01	***Female*** 02	***Gender not focused*** 13

Prisma Flow: The PRISMA diagram [63] of the systematic review is shown in Figure 1.

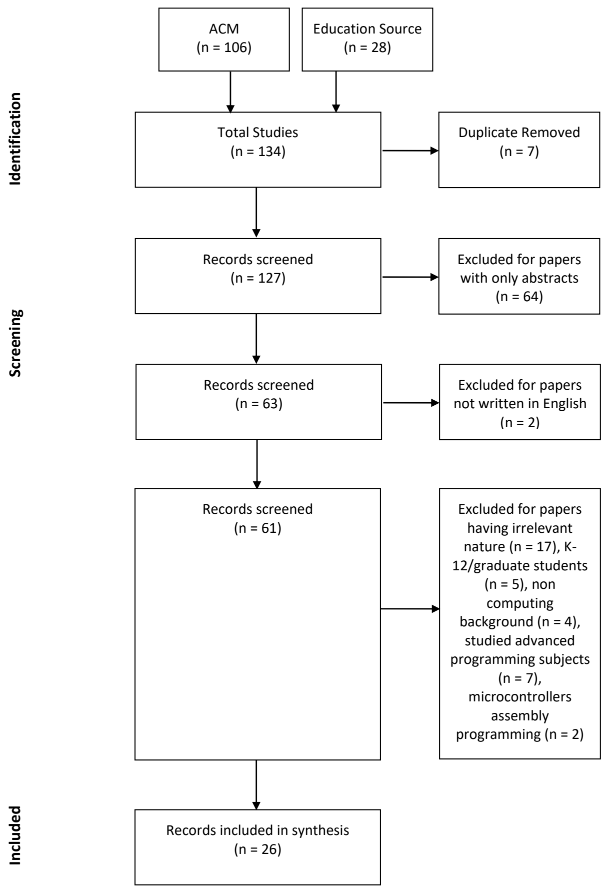

Fig. 1. PRISMA Flow

IV. FINDINGS

Using the content analysis method described earlier, we reviewed the literature and identified three recurring themes: 1) intrinsic motivation, 2) extrinsic motivation, and 3) social cognition. Using Excel, we completed the extraction process. We found that 8 studies were related to pedagogical changes teachers made to influence students' social cognition, 10 were related to extrinsic motivation, and 7 were related to some tools teachers used in their programming courses to increase students' intrinsic motivation. Although many studies fell under one unique category, we found that one study fell under two categories (category 2 and category 3); hence, we included that study in both categories in Figure 2. These themes answer our research question.

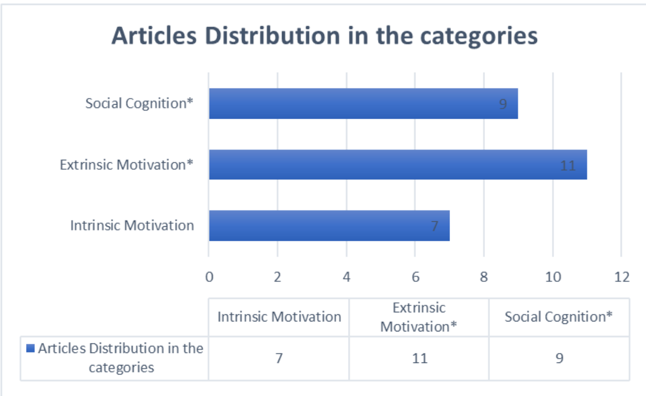

Fig. 2. Distribution of 26 articles based on the thematic classification (*one study is included in two categories).

A. Intrinsic Motivation

Intrinsic motivation is the internal drive that students experience when engaging in programming learning activities [66]. Using tools in the classroom actively engaged students in the learning process, motivating them and keeping them interested in the material.

The studies in this theme describe various ways students could be intrinsically motivated to learn programming. These ways include 1) the use of digital and engaging tools and 2) the use of real-world examples.

It was found that using digital tools in applications, robotics, or games makes learning more engaging [67], [68]. The use of such tools actively engaged students in the learning process. Studies have suggested that tools help students feel more supported and motivated, as they can learn thoroughly. During the analysis, we found that using tools during the learning process increased students' motivation.

In one example, a purposeful study was conducted to determine whether using the IPRE robots motivates students to learn programming [69]. The author used Keller's Instructional Materials Motivation Survey to measure motivation. The results of the study indicated that these robots had a positive impact on students' programming learning. In another example, using games during class effectively motivated students to learn programming [66]. To capture students' imagination, games provided a hook. Findings suggested that letting students do what they liked helped them achieve their motivation.

Studies also found that using real-world examples also helped boost students' motivation. For example, Gallant et al. [70] included labs and a capstone project for teaching Java programming, all linked together and utilizing the Java-based Greenfoot programming environment. Using quantitative techniques, they found that students liked the lab work, and the project excited them to learn programming.

Although independent, using tools and real-world projects also co-existed in literature to enhance students' motivation. For example, in a study [69], the authors found that female students preferred real-world assignments, and male students preferred gaming assignments as motivation when learning how to program. In another example,

The use of Raspberry PI, which is a microcontroller-based developmental board, helped students get a better understanding of the programming while learning [71]. The authors described how the lab component motivates students in quasi-experimental settings [72].

B. Extrinsic Motivation

Extrinsic motivation drives individuals to perform a given task due to external rewards or pressure, such as grades or some recognition [73]. During the analysis, we found various factors that extrinsically motivated students and drove them to persist and learn to program.

For instance, Ngan and Law [74] conducted a cross-sectional study and found that reward, recognition, social pressure, and student competition are the major motivators motivating students to learn programming. Complementing these findings, Lehman and colleagues [75] highlighted the importance of career-related incentives such as the flexibility of remote work and attractive monetary benefits. These extrinsic motivators drive students to enroll in computing degrees and contribute to the nationwide growth in Computer Science enrollments, particularly in the post-pandemic world where economic conditions and high pay scales in computing jobs are highly influential. Additionally, a mixed-method study involving 570 found that family background, interest in the subject, future job prospects, and perceived difficulty are crucial extrinsic factors impacting students' motivation to learn programming [76]. This study also highlighted that while extrinsic rewards are vital, students' intrinsic interest in learning is equally significant [77].

The growth in any major is not only dependent on the enrollment rate but also on the persistence of the people with it. Katz and colleagues [73] investigated the factors that predict performance and persistence in undergraduate CS program students. In a quantitative style study, they traced the performance of 200 students throughout the sequence of courses. Their findings indicated that persistence is highly correlated with achievement. Since persistence can reinforce motivation in the face of challenges and setbacks [78], students often feel a sense of accomplishment and satisfaction that reinforces their motivation [79].

C. Social Cognition

Social cognition refers to how social interactions, collaborative learning environments, and inclusive practices influence students' motivation to learn programming [80]. Teaching programming is difficult, especially if the learners are learning it for the first time. We found articles where instructors modified their pedagogies to combat the challenge of social cognition and enhance students' motivation in programming course courses. These pedagogical changes helped students see the connection between what they're learning and how it is useful for the real world, contributing to students' motivation [81].

For example, Mitchell and colleagues introduced some competitive elements to keep new students motivated and engaged in an introductory computing course [82]. Throughout the course, they asked students to work in teams of six. The challenges assigned to them were incrementing gradually. Results indicated that with the promise of points and team members' help, students remained motivated. Another study by Mason [80] highlighted adopting collaborative learning to enhance students' motivation. In a collaborative learning environment, students are supposed to work in groups. Mason's mixed-method approach with three data sources, including laboratory observations, instructional classroom, and faculty interviews, indicated that students learn with better motivation in a collaborative environment.

Massive Open Online Courses (MOOCs) use various pedagogies to deliver content according to social cognition needs and engage learners. Self-paced learning [83], video lectures, discussion forums, peer review, and personalization are the pedagogical changes in MOOCs compared to normal classroom settings. These MOOC courses have been very famous in learning computing courses in general and programming courses in specific [84], [85], [86]. Hsueh and colleagues [87] examined how these pedagogical changes in MOOCs engaged students and affected their final grades. Their analysis in a MOOC Python course found that animated videos motivated students to learn programming compared to document or textbook reading.

In another study, Morrison and colleagues [88] used the NCWIT Engagement Practices Framework as a means of organization. Their work suggests interventions and practices affecting the inclusiveness in a CS classroom, potentially improving students' learning and motivating them. To improve students' motivation and inclusivity in an online classroom, Letaw and colleagues [89] implemented curricular interventions in online asynchronous online courses. Online students who took these courses reported that they experienced more inclusion in the course than before [90] [91].

V. DISCUSSION

Motivation is a much-needed component that drives someone to learn in a better and more enjoyable way [92]. Many factors contribute to students' motivation for learning programming, including pedagogical changes, tool usage in classrooms, and students' persistence. These factors reinforced motivation among students, which in turn improved learning.

Based on our systematic review, 26 studies we found relevant after applying the inclusion and exclusion criteria fall under three categories. The synthesized studies are listed in Table 5. We classified them into 1) intrinsic motivation, 2) extrinsic motivation, and 3) social cognition. These categories helped us identify the identical findings across studies. We gathered firsthand factors that motivate students to learn programming by digging deeper into these articles.

The key highlights of these results demonstrate the importance of intrinsic and extrinsic motivational factors and social cognition in learning programming. Using digital tools and real-world examples enhances students' intrinsic motivation, while external factors such as rewards, recognition, and social pressure contribute to students' extrinsic motivation. Additionally, pedagogical approaches that foster collaborative learning environments and inclusive practices significantly promote social cognition and enhance students' motivation in programming courses.

These results suggest that addressing motivating factors is essential for promoting student engagement [26] and success in learning programming [27]. Also, it underscores the critical link between students' motivation, class engagement, and academic performance. During the synthesis, we found that the researchers utilized quantitative and qualitative approaches, but multi-model strategies to study the students' motivation to learn programming are lacking [93], [94].

Future directions in learning programming effectively could include designing tailored interventions to enhance student motivation to learn. Additionally, a deeper exploration of complex aspects of motivation shaped students' overall learning experiences.

VI. LIMITATIONS

Despite our diligent efforts in this study, some limitations are inherent in conducting a systematic literature review.

For example, one known risk that affects validity is the failure to identify enough relevant articles. We constructed our database by searching for indexed articles in the ACM digital library and Education Source to mitigate it. However, we acknowledged that some relevant articles may be beyond the databases we explored. These articles could escape our synthesis because of the limits of our search scope. Additionally, our sample size is limited, potentially overlooking relevant articles and reducing the comprehensiveness of our findings.

Similarly, we may have missed some synonyms while making our search string, which might be used in the literature to discuss the same phenomenon. Additionally, during the manual inspection of the articles, we disposed of irrelevant articles. Although bias was minimized in the process, there still may be some unknown inherent biases. Lastly, we must note that we extricated the information relevant to our research questions while synthesizing. Shifting the focus to other problems would bring different information from the same studies. In addition, publication bias may have influenced our findings, as factors not covered or unpublished studies could introduce potential biases into the synthesized literature.

In future studies, addressing these limitations could yield valuable insights. Expanding the search scope to include a broader range of databases and incorporating additional search terms could enhance the comprehensiveness of the review.

VII. CONCLUSION

The implications of these results highlight the factors that motivate students both intrinsically and extrinsically in learning programming.

The results of this study are important as they provide an understanding of the factors that motivated students to learn programming, which will help instructors align their courses to the needs of the students. These results advance scholarship in engineering education by highlighting categories that shape students' motivation to learn to program.

Also, these results can inform instructors and educators on approaches to redesigning their programming courses by keeping students' motivation and associated factors in view. Implementing motivational strategies and adding inclusive teaching practices to support students' social cognition can create an engaging learning experience. We believe that by incorporating the factors synthesized, educators can create enriching learning environments that empower students to succeed in programming education and beyond.

TABLE 5. BIBLIOGRAPHY OF THE SYNTHESIZED ARTICLES

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