The Effects of Learning How to Learn on Gen-Z Students' STEM and Internet Skills

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Abstract

This study explored the effects of learning how to learn on Gen-Z students' interest, confidence, and quality of learning in STEM subjects and their internet usage. The research question was: How can learning how to learn help Gen-Z students in STEM education and their daily internet activities? The research design was a mixed methods approach that combined quantitative and qualitative data collection and analysis. The data sources were questionnaires and observations of students from NGS Kampong Cham who participated in five sessions of learning how to learn training. The results showed that the training had positive effects on the students' satisfaction, learning strategies, feedback, and internet behavior. However, the training did not have significant effects on the students' ability to apply, explain, or solve problems in STEM subjects. We suggested some implications and recommendations for future research and practice, such as conducting more studies to examine the long-term effects of learning how to learn training, using more rigorous methods to evaluate the impact of learning how to learn training on student ability, including more diverse samples to generalize the findings of learning how to learn training, developing more innovative and effective ways to integrate learning how to learn into the curriculum and instruction of STEM subjects, and establishing more collaboration and communication between stakeholders to promote and support learning how to learn as a key skill for lifelong learning.

1. Introduction

The ability to learn how to learn is a crucial skill for students in the 21st century, especially in the fields of science, technology, engineering, and mathematics (STEM). Learning how to learn refers to the metacognitive strategies that enable learners to plan, monitor, and evaluate their own learning processes and outcomes. It also involves the use of various sources of information, such as the internet, to support learning. Learning how to learn can enhance students' motivation, engagement, understanding, and performance in STEM subjects, as well as their internet usage and behavior. However, not many students have been taught how to learn effectively on their own.

Most students rely on instruction from teachers or textbooks to acquire knowledge and skills. They also face challenges in using the internet for learning purposes, such as finding reliable and relevant information, evaluating its quality and validity, and applying it to solve problems. These challenges can hinder students' quality of learning and potential development. Therefore, our research aims to explore the relationship between learning how to learn and Gen-Z students' interest, confidence, satisfaction, quality of learning, and use of learning strategies and feedback in STEM subjects and their internet usage. Gen-Z students are those who were born between 1995 and 2010. They are characterized by their openness, inclusiveness, technological savvy, pragmatism, and social consciousness (Vojvodić, 2019).

To achieve this aim, our research adopts a mixed methods design that combines quantitative and qualitative data collection and analysis. Our research involves guiding students through five sessions from the lens of learning how to learn. The sessions cover topics such as how to use the internet for learning, how to learn science, technology, engineering, and mathematics. The data collection methods include questionnaires before and after the sessions, as well as one month after the sessions. The data analysis methods include descriptive statistics, inferential statistics, and thematic analysis. Our research is expected to contribute to the literature on learning how to learn in STEM education and internet usage among Gen-Z students. It is also expected to provide practical implications for teachers, educational institutions, and policy makers on how to improve students' learning outcomes and potential development by teaching them how to learn effectively on their own.

1.1 Literature Review

Generation Z, also known as iGen or Gen Z, is the cohort of people born between 1995 and 2010, who are currently entering or graduating from higher education and joining the workforce. Generation Z is characterized by their digital nativity, social media usage, desire for uniqueness, co-creation, personalization, and social interaction, as well as their confidence, optimism, and responsibility (Vojvodić, 2019). Generation Z also faces high levels of stress and loneliness due to the effects of the Great Recession, the COVID-19 pandemic, and the lack of in-person social interaction (Seibert, 2021).

STEM education is a global movement of educational practice that integrates content and skills from science, technology, engineering, and mathematics to solve real-world problems and develop students' STEM literacy and 21st century skills (Kefalis & Drigas, 2019). STEM education has been shown to improve students' abilities in problem solving, innovation, creativity, collaboration, communication, and character building (Fajrina et al., 2020). STEM education also aims to prepare students for the challenges and demands of the 21st century workforce, especially in the fields of science and technology.

The literature on Generation Z and STEM education reveals some common themes and research gaps. One theme is the influence of technology on Generation Z's learning preferences and outcomes in STEM education. Technology can enhance learning in STEM education by providing accessibility, flexibility, motivation, digital literacy, and real-world relevance (Kefalis & Drigas, 2019). However, technology can also pose some challenges and limitations, such as technical issues, pedagogical design, assessment methods, and ethical considerations (Widya et al., 2019). Moreover, technology can affect Generation Z's social development and communication skills, which are essential for STEM education and careers (Rosyiddin & Afandi, 2022).

Another theme is the need for effective teaching strategies and curriculum design to engage Generation Z in STEM education. Some of the suggested strategies include integrating active and problem-based learning (Fajrina et al., 2020), using visual and interactive media (Vojvodić, 2019), engaging creativity and innovation (Kefalis & Drigas, 2019), helping students make connections and find meaning (Seibert, 2021), and providing feedback and encouragement (Hinojo-Lucena et al., 2020). Some of the suggested curriculum design elements include balancing technical fundamentals with professional practice (Moore et al., 2017), integrating design and creativity throughout the curriculum (Schwieger & Ladwig, 2018), fostering lifelong learning and critical thinking skills (Hathaway & O'Shields, 2022), and aligning with the national education goals and vision (Simbolon et al., 2021).

A research gap that emerges from the literature is the lack of empirical studies on the impact of Learning How to Learn of STEM education on Generation Z's learning outcomes and skills development. Most of the studies are conceptual or descriptive in nature, providing theoretical frameworks or practical recommendations for STEM education. However, there is a need for more quantitative or qualitative data to measure and evaluate the effectiveness of STEM education for Generation Z students. For example, how does STEM education affect Generation Z's academic achievement, motivation, interest, confidence, career aspirations, and satisfaction in STEM fields? How does STEM education influence Generation Z's development of 21st century skills such as critical thinking, creativity, communication, and collaboration? How does STEM education prepare Generation Z for the future workforce and society?

In conclusion, the literature on Generation Z and STEM education provides some insights into the characteristics, needs, preferences, and challenges of this young cohort as learners in science and technology. It also offers some suggestions for improving STEM education to better suit Generation Z's expectations and prepare them for the 21st century. However, there is a need for more empirical research to assess the impact of Learning how to Learn for STEM education on Generation Z's learning outcomes and skills development.

2. Research Methods

The method that we used to conduct this research was a mixed methods design. This is a type of research design that combines both quantitative and qualitative data collection and analysis that allows us to capture both the numerical and the narrative aspects of our research topic. We used quantitative and quantitative methods in the form of Open-ended questions, Likert, and Rating questions to measure the outcomes of our training session and observed all students throughout our training to understand students' perceptions, experiences, and challenges related to learning how to learn on STEM subjects and Internet usage.

To collect our data, we guided students through five sessions from the lens of learning how to learn. We taught them the skill of how to learn through examples, and those examples are sessions on STEM and the Internet. From the sample size of 74 students at NGS Kampong Cham, we have separated the training session into two weekends (Sat, and Sun) to ensure the effectiveness of our training. Those sessions are about how to learn, so we trained them on how to learn from the internet such as searching, evaluating, and using online information, and how to learn about science, technology, engineering, and mathematics. During the 2 days of training, we did questionnaires to collect the data for pre-session, post-session and 1 month after the training session.

The context of the data we collected:

1. Pre session (google form)
   a. measure students' internet behavior
   b. measure students' motivation, engagement, and understanding in STEM subjects.
2. Post sessions questions (google form)
   a. measure students' internet behavior
   b. measure students' motivation, engagement, and understanding in STEM subjects.
3. 1 moth after the training session (google form)
   a. measure students' internet behavior 1 month after the training session:
   b. measure students' motivation, engagement, and understanding in STEM subjects 1 month after the training session.

Data analysis Insight from 'Pre-session (Responses): analysis'

1. Most respondents use the internet frequently for learning or personal purposes, indicating a reliance on technology for education and self- improvement.

2. A significant portion of respondents spend between 4 to 8 hours online per day, suggesting that they are moderate to heavy internet users.

3. While most respondents rated their internet usage and habits as average to above average, there is still a significant portion who rated their management as below average, indicating room for improvement in managing internet usage.

4. Most respondents are satisfied with using the internet and their habits, but there is still a notable portion who are dissatisfied or only somewhat satisfied.

5. A significant portion of respondents do not feel that they use the internet in a positive or effective way, indicating a need for improvement in utilizing online resources.

6. Most respondents take steps to avoid or minimize the negative effects of the internet, suggesting a high level of awareness and effort in internet safety.

7. Most respondents can balance their time and attention between online and offline activities, indicating a level of self-regulation in internet use.

8. While most respondents claim to protect their privacy and security when using the internet, there is still room for improvement in terms of

9. internet safety practices.

10. The internet appears to have a positive impact on reducing stress, anxiety, or loneliness for most respondents, but there are still some who do not experience these benefits.

11. Most respondents actively use learning strategies when using the internet, indicating intentionality in their online learning.

12. There is a significant level of interest in STEM subjects among the surveyed population, with most respondents being moderately to very interested.

13. A significant number of respondents put in moderate to high effort into learning STEM subjects, indicating a dedication to their education in these fields.

14. Confidence in understanding STEM subjects varies among respondents, with no single rating being significantly more common than others.

15. Most respondents have a strong interest in studying STEM, indicating a desire to pursue careers in these fields.

16. STEM education is important to a significant portion of the respondents, with a majority indicating that they attend STEM classes or activities.

17. A significant proportion of respondent’s value feedback as a tool for improving their learning in STEM subjects, but there is still a minority who do not see its value.

18. There may be a gap between STEM education and its practical application in real-world situations, as most respondents do not apply what they learn to specific problems or situations.

19. There is room for improvement in terms of communicating and explaining STEM concepts and skills to others, as most respondents do not engage in these practices.

20. Many respondents feel capable of solving challenging or complex issues in STEM subjects, indicating confidence in their abilities.

21. There is a strong desire among respondents to seek solutions or create and innovate in STEM-related fields, indicating a passion for these areas.

22. Searching for online information is a common and important practice for many people, with the majority doing so often or always.

23. Consistently evaluating the accuracy and reliability of online information could be improved, as a significant portion of respondents do not always do so.

24. Online information is commonly used among respondents, with the majority frequently using it.

25. Taking online courses or tutorials is a common practice, but not done frequently by everyone.

26. Online communication is a common and important aspect of modern life, with the majority of respondents reporting that they do so often or always.

27. Playing games online or watching videos is a common activity among

28. respondents, with a majority doing so often or always.

29. Regular review of previous lessons or materials on STEM subjects is not consistently practiced by all respondents, suggesting room for improvement in encouraging review.

30. Practicing exercises or problems on STEM subjects is a common practice, especially sometimes or often, indicating an active approach to learning.

31. Asking questions or seeking clarifications on STEM subjects is a common

32. practice, with most respondents doing so sometimes or often.

33. Working with peers or teachers on STEM subjects is a common occurrence, but not for everyone, suggesting a potential need for more opportunities for collaboration.

34. Looking for new topics or resources on STEM subjects is a common practice, indicating an interest in staying updated and informed.

35. Making connections or comparisons between STEM subjects is a common practice.

Insight from 'Post-session (Responses): analysis'

1. The participants rated their learning, confidence, satisfaction, and quality of the training session highly, with most of them giving scores of 8 or higher on a scale of 1-10.

2. The participants enjoyed the friendly and fun nature of the team facilitating the sessions, the inclusion of games and activities, the opportunity to learn and try out new things, and the explanation and concept clarity provided by the trainers.

3. The participants did not have any major suggestions for improving the training session, and most of them did not have any complaints or dislikes about it.

4. The participants used the internet for various purposes, such as research, entertainment, learning, communication, and problem-solving. They also mentioned some benefits and challenges of using the internet, such as convenience, access to knowledge, information overload, and lack of interaction. 6

5. The participants had different approaches to searching, evaluating, and using online information, but common themes included reliance on search engines and verifying the accuracy of the information found.

6. The participants did not mention specific strategies to apply learning how to learn techniques when using the internet, but one participant mentioned setting goals, planning, arranging activities, seeking constructive criticisms, and utilizing multiple sources.

7. The training session had varied effects on the participants' internet behavior or habits. Some mentioned positive changes, such as using it responsibly, focusing on necessary tasks, and utilizing it for educational purposes. Others mentioned no impact or negative effects, such as relying on their own experience or mentors or feeling unmotivated or unengaged.

8. The participants gave some examples of how they used the internet in a positive or productive way after the training session, such as watching history videos, reading online books, doing research for assignments, learning new skills, and developing a solution.

9. The participants also gave some examples of how they avoided or reduced the negative or harmful effects of the internet after the training session, such as limiting internet usage, distrusting media, disconnecting from devices, increasing privacy measures, combating laziness, developing critical thinking skills, maintaining mental health, and reducing overall internet usage.

10. The participants had varying approaches to balancing their time and attention between online and offline activities. Some did not actively balance their time, while others used methods such as creating a to-do list or using a schedule.

11. The participants used various methods to protect their privacy and security when using the internet. These included creating strong passwords, using a VPN (Virtual Private Network), being cautious with personal information, learning about cookies and tracking, and implementing additional security measures.

12. Most of the participants coped with stress, anxiety, or loneliness when using the internet by engaging in activities that provide entertainment or distraction. Some also connected with others through online friendship by talking to friends.

13. Most of the participants were interested in learning STEM subjects because they found them interesting, fun, and important today. Some also mentioned that studying STEM subjects can benefit their daily lives and lead to potential career opportunities. A few were not interested because they believed they did not possess the necessary skills or because the subjects did not meet their expectations.

14. Most of the participants felt positively about learning STEM subjects. They expressed feelings of enjoyment, excitement, curiosity. Some also mentioned feeling confident and normal when studying STEM. However, one response suggested that there could be room for improvement or innovation in the learning experience.

15. The most common way that the participants participated or contributed in STEM classes or activities was by working with others, collaborating on projects, or sharing ideas. This suggests that they valued teamwork, communication, and social interaction in STEM learning. A few did not know how to participate or contribute or did not participate or contribute at all.

16. The most common way that the participants used feedback to improve their learning in STEM subjects was by doing more exercises, reviewing the materials, or starting with the basics. This suggests that they valued repetition, reinforcement, and mastery in STEM learning. A few did not know how to use feedback effectively or did not use feedback at all.

17. Only a few of the participants mentioned some specific ways to apply what they learned in STEM subjects to real-world problems or situations, such as using critical thinking and imagination, learning how to fix some basic stuff and do some coding, developing a solution, or using this knowledge to help 7 those in need. Most did not know how to apply what they learned in STEM subjects to real-world problems or situations or did not apply them at all.

18. Only a few of the participants mentioned some specific ways to explain the concepts and skills they learned in STEM subjects to others, such as using examples, imagination, or real-world applications. Most did not know how to explain what they learned in STEM subjects to others or did not explain them at all.

19. Only a few of the participants indicated that they used strategies such as starting with small problems, doing research, asking for help, or understanding the solution and generalizing it to solve challenging or complex problems in STEM subjects. These are some of the skills that are recommended by experts in problem-solving in STEM. Most did not know how to solve challenging or complex problems in STEM subjects or used the internet or other apps to help them solve problems.

20. Most of the participants gave positive feedback on the training session, indicating that it improved their motivation, engagement, understanding, and performance in STEM subjects. They mentioned benefits such as learning without boredom, having more interest, options, and perspectives, and gaining new knowledge and skills. Some gave neutral or vague feedback on the training session, indicating that it had little or no impact on their motivation, engagement, understanding, and performance in STEM subjects. Only a few gave negative or mixed feedback on the training session, indicating that it did not improve their motivation, engagement, understanding, and performance in STEM subjects.

Insight from 'One month after the training session (Responses): analysis'

1. Positive Attitudes towards STEM: Most respondents expressed positive attitudes towards learning STEM subjects, emphasizing their enjoyment, interest, and the importance of these subjects in today's world.

2. Benefits of STEM Learning: Respondents highlighted various benefits of learning STEM subjects, including gaining insights, enhancing problem-solving skills, improving self-esteem, and acquiring practical skills applicable in real life.

3. Challenges of STEM Learning: Some challenges identified by respondents include difficulty in understanding complex concepts, struggling with problem-solving, weak mathematics skills, and the resource-intensive nature of STEM learning.

4. Strategies for Improving STEM Learning: Strategies mentioned by respondents to improve STEM learning include scheduling study time, self-studying, doing more exercises, reviewing subjects before exams, and utilizing online resources.

5. Application of STEM Knowledge: Respondents expressed a need for further guidance and instruction on how to effectively apply STEM knowledge to real-world problems or situations.

6. Explanation of STEM Concepts: Strategies for explaining STEM concepts included breaking down complex ideas, providing examples, utilizing hands-on demonstrations or visual aids, and fostering a supportive learning environment.

7. Problem Solving in STEM: Strategies for solving challenging or complex problems in STEM subjects include breaking problems down into smaller steps, seeking help from others, and utilizing helpful tools or apps.

8. Use of Internet for Learning: Respondents reported using the internet for various learning purposes, such as online research, watching educational videos, accessing teaching materials, and seeking tutorials.

9. Use of Learning How To Learn Strategies: Respondents mentioned using Learning How To Learn strategies when studying STEM subjects, including self-study, focusing on understanding, active learning techniques, and following instructions.

10. Impact of Training Session: The training session positively impacted respondents' motivation, engagement, understanding, and performance in STEM subjects. However, some respondents expressed uncertainty or the need for further understanding regarding the specific impacts of the training.

11. Internet Usage and Behavior: The training session improved participants' internet behavior and habits by teaching them how to use the internet in a valuable way, balance their time, and manage their online activities.

12. Balancing Time and Attention: Strategies for balancing time and attention between online and offline activities included scheduling, setting timers, and prioritizing non-online work.

13. Privacy and Security: Common strategies for protecting privacy and security online include using strong passwords, avoiding suspicious websites and links, keeping software up to date, utilizing VPNs, and being cautious with personal information sharing.

14. Using the Internet for Emotional Well-being: When feeling stressed, anxious, or lonely, respondents turned to the internet for entertainment, distraction, and connection with others.

15. Overall, the survey results highlight the importance of positive attitudes towards STEM learning, the benefits and challenges of learning STEM subjects, the application of STEM knowledge to real-world problems, and the effective use of the internet and Learning How To Learn strategies for learning and personal development. The training session had a positive impact on participants' motivation, engagement, understanding, and performance in STEM subjects, while also improving their internet behavior and privacy-awareness.

3. Result and Discussion

Results

The results of our research showed that teaching students methods to learn STEM subjects and the way to use the internet to learn had positive effects on their understanding and skills. The quantitative data analysis revealed that the participants' ratings of their interest, confidence, satisfaction, effort, and quality of learning in STEM subjects increased significantly after the training session and remained high one month later. The qualitative data analysis indicated that the participants improved their internet usage and behavior by using the internet for various learning purposes, applying learning how to learn strategies, protecting their privacy and security, and coping with stress and loneliness. The results also suggested some areas that need further improvement, such as applying STEM knowledge to real-world problems, explaining STEM concepts to others, solving challenging problems in STEM subjects, and providing more guidance and feedback on learning how to learn. The results of our research contribute to the knowledge and practice of the field by providing evidence-based recommendations for using learning how to learn as an effective strategy to enhance students' 21st century skills and prepare them for their future careers.

Discussion

The purpose of our research was to investigate how teaching students' methods to learn STEM subjects and the way to use the internet to learn can improve their understanding and skills. The research was conducted using a mixed methods design that involved questionnaires and observations of 74 students from NGS Kampong Cham who participated in five sessions of learning how to learn. The findings showed 9 that the training session had positive effects on students' interest, confidence, satisfaction, effort, quality, and internet usage and behavior in STEM subjects. However, the training session did not have significant effects on students' ability to apply, explain, and solve problems in STEM subjects. These results suggest that learning how to learn can enhance students' motivation and engagement in STEM education, but it may not be sufficient to develop their higher-order thinking skills and competencies.

The findings of our research are consistent with some previous studies that have reported the benefits of learning how to learn for students' academic achievement and self-regulated learning (Donaher & Wu, 2020; Ranieri et al., 2021; Seibert, 2021). However, they also reveal some gaps and challenges in implementing learning how to learn in STEM education, such as the need for more guidance and instruction on how to apply STEM knowledge to real-world problems or situations, how to explain STEM concepts and skills to others, and how to solve challenging or complex problems in STEM subjects. These findings are in line with some other studies that have identified the difficulties and limitations of teaching and assessing higher-order thinking skills in STEM education (Kefalis & Drigas, 2019; Moore et al., 2017; Widya et al., 2019).

The implications of our research are that learning how to learn can be a useful strategy to foster Generation Z's critical thinking and perseverance in STEM education, but it needs to be complemented by other strategies that can address the specific needs and characteristics of this generation. For example, some possible strategies are integrating design and creativity throughout the curriculum, providing experiential learning opportunities, using smart technologies and online tools, engaging students in productive teamwork, involving students in inquiry and open exploration, and emphasizing STEM practices (Fajrina et al., 2020; Schwieger & Ladwig, 2018; Vojvodić et al., 2019). Moreover, learning how to learn needs to be aligned with the national education goals and vision, as well as the expectations and demands of employers and the society in the 21st century.

The limitations of our research are that it only involved a small sample of students from one school in Cambodia, which may limit the generalizability of the findings. Furthermore, it did not use a control group or baseline test data to compare the impact of the training session on student outcomes. Additionally, it relied on self-reported data from questionnaires and observations, which may be subject to bias or error. Therefore, future research should use a larger and more diverse sample of students from different schools and regions, employ a quasi-experimental or experimental design with a control group or a pre-test/posttest measure, and use multiple sources of data collection and analysis, such as interviews, focus groups, portfolios, or standardized tests.

In conclusion, our research has contributed to the knowledge and practice of learning how to learn in STEM education by providing insights into its effects on Generation Z students' motivation, engagement, understanding, skills, and internet usage and behavior. It has also identified some challenges and opportunities for improving learning how to learn in STEM education by suggesting some recommendations for future research and practice. Learning how to learn is a valuable skill for Generation Z students who need to adapt to the fast pace of technological change and the demands of the 21st century. However, it is not a magic bullet that can solve all the problems in STEM education. It needs to be integrated with other strategies that can enhance students' higher-order thinking skills and competencies in STEM subjects.

4. Conclusions

The aim of our research was to explore how learning how to learn can help Gen-Z students in STEM education and their daily internet activities. The research was conducted using a mixed methods design that 10 involved questionnaires and observations of 74 students from NGS Kampong Cham who participated in five sessions of learning how to learn. The findings revealed that the training session had positive effects on students' interest, confidence, satisfaction, effort, quality, and internet usage and behavior in STEM subjects. However, the training session did not have significant effects on students' ability to apply, explain, and solve problems in STEM subjects. These results suggest that learning how to learn can enhance students' motivation and engagement in STEM education, but it may not be sufficient to develop their higher-order thinking skills and competencies.

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