Asia Pacific Journal of Advanced Education and Technology
Special Issue, September 2022 / P- ISSN 2815 – 245X / E – ISSN 2815 – 2468 / www.apjaet.com

Development of Chatbot Supplementary Tool in Science and the Self-Regulated Learning Skills among the Grade 10 Students

Gareth Robert M. Prondoza[1], Julie Fe D. Panoy, Ph.D.[2]
https://orcid.org/0000-0001-5452-086X[1], https://orcid.org/0000-0003-4886-3414[2]
garethrobert.prondoza@deped.gov.ph[1], juliefe.panoy@lspu.edu.ph[2]
Mabato National High School, Division of Calamba City
Laguna State Polytechnic University, Laguna Philippines

DOI: https://doi.org/10.54476/apjaet/95445

Abstract

This study focused on determining the effectiveness of a developed interactive chatbot as a supplementary tool in studying Science and observing the manifestation of self-regulated learning skills among the Grade 10 students in Mabato National High School. It used a descriptive developmental research design participated by 35 students. Using the Mean and Standard Deviation, results revealed that the features of the evaluated chatbot are highly effective. This implies that the developed interactive Science Chatbot can be used as supplementary material in studying Science in a blended learning modality. Most respondents manifested the description of Self-regulated Learning Skills in terms of goal setting, self-monitoring, self-instruction, and self-reinforcement. This means that the skills were present and visible during the material delivery. The respondents' Level of Satisfaction with the Use of Interactive Chatbot in terms of usage and content, language used, perception, and difficulties and limitations, most of them agreed that they were satisfied when using the developed interactive chatbot. For treating the difference in the pre-and post-test scores of the respondents in the science competencies test, a t-test was used. The results show a significant difference between the pre-test and post-test. It indicated that the chatbot features affect their test performance because they used it as a reviewer and can return to the topic that appears unclear to them. The result also implies that the chatbot was effective in assisting students in improving their performance on the science competencies test.

Keywords: Self-Regulated Learning Skills, Chatbot, Science Competencies, Supplementary Tool

Introduction

Education is one of the most impacted industries when a pandemic hits the country. Learners stay on the four corners of their homes while the teachers continue to find their way on how the education of the learners must continue. In the new typical setup, learners were given options on what modality to cope with the scenario we are facing right now. As stated in DepEd Order No. 12 series of 2020, each institution should craft their School Learning Continuity Plan based on the community's situation concerning the quarantine classification raised on the area where the students could select modalities that best suited their situation and location.

Mabato National High School is one of the far-flung institutions in the City of Calamba, with a low number of learners enrolled every school year. The institution offered a blended learning modality wherein the learners participated in a one-week limited in-person class and another week of distance

learning. Learners faced different challenges during a distance learning modality wherein there were instances that they did not understand the content of the materials or terminologies related to science. When the students are alone or even with their parents or guardians who are not that well educated, they find it difficult to understand various content. Aside from the challenges the learners face in studying Science, the lone teacher teaching the said learning area also faces challenges, especially in the distribution of the learning materials. Teachers' distribution and physical assistance depend on the Quarantine Classification implemented in a particular site.

If the guidelines implemented in the community are so strict, teachers will be impeded from entering the institution, especially if they are from other cities/ municipalities. With the implementation of strict guidelines, a detailed explanation of the designed learning tasks for the week would not be done by the subject teacher.

In this generation, interactional educational agents use different techniques to integrate Artificial Intelligence (AI) to improve and customize education automation. Chatbots in education can improve academic achievements and student contentment significantly. (Winkler & Söllner, 2018). Hosting a chatbot on an instant messaging network, including Facebook Messenger, benefits from a user-friendly interface in the mobile infrastructure. With minimal institutional and financial resources, personal learning support can be provided using chatbots.

This research is founded on the Theory of Self-Regulation, the Technology-mediated Learning (TML) concept, and the competencies prescribed by the K to 12 Science Education Curriculum Framework.

According to Zimmerman (2011), self-regulated learning is defined by how students gain control over their learning processes. It is the self-directed process by which abilities in various professions are transformed into task-related skills. It is not a mental or performance ability. “Self-Regulated learning”, as mentioned by Winne and Hadwin (2010), always takes place in the context of a task that the learner is working on. Self-regulation abilities include setting goals, monitoring self, self-instruction, and reinforcing oneself. The skills mentioned above must avoid confusion about the mental abilities and even the academic capabilities of learners.

The study was predicated on the ideas of Chatbot-mediated Learning (CML) which is considered one way of Technology-mediated Learning (TML). It depicts a learning environment in which students employ chatbots to improve the quality and outcome of their Learning (Winkler & Söllner,2018). CML's essential potential is to give individual support because as classes get more significant and personal support becomes more complex, chatbots can assist both instructors and students (Winkler & Söllner, 2018). Chatbots can assist learners in achieving goals such as passing an external standardized exam or improving their English skills on the job. Chatbots can employ AI to analyze student data and provide teachers feedback, in addition to personalizing content to learners' requirements.

Moreover, Winkler & Söllner (2018) emphasize determining how new IT can be seen. Users must consider various factors, including compatibility, complexity, content, and language. Complexity is therefore considered when evaluating perceived thoughts about chatbots. A chatbot must be accepted and used to be simple to use and not require too much effort to become familiar with. It is critical that the user understands chatbots and their aims and goals. If not, the user may believe that the Chatbot is overly complex and will not consider using a bot (Winkler & Söllner,2018). Aside from complexity, compatibility issues arise when utilizing a chatbot as a pedagogical tool. Potential adopters perceive innovation to be consistent with their existing beliefs, needs, and past experiences. One of these factors is the degree to which the creation provides an advantage over the traditional method. It encompasses aspects like getting started with the bot, the design, moving within the bot, and comprehending its content.

The K–12 Curriculum integrates science content and science processes. Students will struggle to apply science process skills without the content because these processes learn best in context organizing the curriculum around situations and problems that challenge and pique students' interest and motivates them to see science as relevant and valuable. Rather than relying solely on textbooks, students engage in various hands-on, mind-on, and heart-on activities that help them develop their interests and become active learners. Integrating science across other disciplines will help the learners to understand further how students can apply learning competencies to more complex and realistic world situations.

People nowadays are curious about how educators and learners can use chatbots for teaching and learning since the introduction of chatbots into the educational sector over the past decade. Functional chatbot systems can offer the same benefits as interviews, such as immediate availability and the ability to respond naturally via a conversational interface. One advantage of using chatbots in education is that content can be integrated so that learners can quickly understand the topic by code-switching or using a language they understand.

Objectives of the Study

The primary goal of this study was to develop a supplementary interactive science chatbot that would possibly enhance the science competencies and self-regulated learning skills of the grade 10 students in Science at Mabato National High School. It specifically intended to 1) evaluate the effectiveness of the developed interactive science chatbot in terms of language; content; compatibility; and complexity; 2) describe the learners respondent's self-regulated learning skills based on their goal-setting; self-monitoring; self-instruction; and self-reinforcement; 3) determine pre-test and post-test scores of the respondents in the Grade 10 Science competencies test; 4) describe the respondents' level of satisfaction in the use of the interactive chatbot in science 10 in terms of usage and content; language; perception; and difficulties and limitations; 5) determine whether there is a significant difference between the pre-test and post-test scores of Grade 10 Science competencies test respondents.

Methodology

This study is a descriptive developmental study. The researcher used a total enumeration sampling due to the low enrollment rate of the institution every school year. There was 35 grade ten students who participated in this study. The conduct of study involved four phases: I) Development of the Interactive Chatbot and Research Instruments, II) Evaluation of Developed Interactive Chatbot and Validation of the Research Instruments, III) Pilot Testing, and lastly, IV) Data Analysis.

Phase I involved the development of an interactive science chatbot and the research instruments. The researchers developed the proposed interactive chatbot using "ManyChat," an open educational resource under creative commons. The researcher used four research instruments in this study. First is the Chatbot Evaluation Tool Checklist, which focuses on the developed chatbot's language, content, compatibility, and complexity features. The second is a Grade 10 Questionnaire on Self-Regulated Learning Skills (QSLS), which assesses respondents' self-regulated learning skills in goal setting, self-monitoring, self-instruction, and self-reinforcement. The third is a Grade 10 Pre- and Post-Science Competencies Test, which assesses the learners' performance on Most Essential Learning Competencies (MELCs) in science 10 embedded in the developed interactive chatbot. And lastly, the Respondents' Perception of using the Interactive Chatbot Questionnaire (RPICQ), which was used after utilizing the developed chatbot.

Phase II involved validating the research instruments and evaluating the developed interactive science chatbot. The researchers' panel of experts participated in the internal validation of the research instruments. Afterward, external validation of research instruments was carried out to extrapolate the potential results of a study to other instances, people, settings, and measures. The said activity was participated by the following experts in teaching the field of science such as a Principal from Canlubang Integrated School, a Science Coordinator from Calamba Bayside Integrated School, a Head Teacher from Tuntungin-Putho Integrated National High School, a Master Teacher from Dasmarinas Integrated National High School, and a Public School District Supervisor from Sta. Rosa City served as a language specialist. The said experts focused on validating the appropriateness of the contents of the instruments. After the validation, the researcher consolidated all the suggestions and recommendations and keenly revised the final copy of the instruments used in the study.

The developed interactive chatbot, and the Grade 10 Pre- and Post-Science Competencies Test underwent content and language validation which was participated in by the above-mentioned experts. On the other way around the researcher-made questionnaires like the Grade 10 Questionnaire on Self-Regulated Learning Skills (QSLS), and Respondents' Perception of using the Interactive Chatbot Questionnaire (RPICQ) underwent reliability through computing the Cronbach's Alpha via SPSS. QLSLS showed an "acceptable" internal consistency in Goal setting (0.778), Self-monitoring (0.775), and Self-instruction (0.743), while the result showed an internal consistency of "good" for Self-reinforcement (0.879). RPICQ results showed that only three subscales passed the reliability testing; those are usage and content with an internal consistency as "acceptable" (0.782), perception of the use of a chatbot as "acceptable" (0.756), and difficulties and limitation with an internal consistency as "'good" (0.900). Unfortunately, the language subscale failed to meet the required internal consistency. The researcher revised the language subscale part of the instrument and ran a second round of pilot testing with the same students who took the first round. After collecting the necessary data, the researcher discovered that the said subscale was still unacceptable, but based on the data provided by the SPSS, removing the third indicator produced a result of 0.685. Although 0.7 is the accepted value for Cronbach's alpha, Ursachi et al. (2015) and Taber (2018) it was agreed that scores greater than 0.6 are also appropriate for such reliability of a survey questionnaire created by a researcher.

Before implementing Phase III, the pilot testing, the researchers sought approval from the school head of Mabato National High School to conduct the study during the third quarter grading period. After the researcher received the support of the school head, the researcher also gave parental consent to the parents to seek permission for the participation of grade 10 students who joined the study. When the approval was granted, the instruments were administered to the respondents.

Phase IV involved the analysis and interpretation proper. The data gathered from the conducted survey questionnaires were statistically treated using descriptive statistics such as mean and standard deviation were used, and the t-test was performed to see if there was a significant difference in the learners' pre-test and post-test science competency scores. Furthermore, in accordance with the country's data privacy policies, the researchers maintained the confidentiality of the gathered data by presenting it anonymously.

Results and Discussion

1. Effectiveness of the Developed Interactive Science Chatbot

Table 1
Summary of Experts' Respondent's Evaluation of the Effectiveness of the Developed Interactive Science Chatbot

Features	Number of Indicators	Mean	SD	Interpretation
Language	5	3.92	0.55	Highly Effective
Content	10	3.78	0.45	Highly Effective
Compatibility	10	3.80	1.58	Highly Effective
Complexity	10	3.84	1.14	Highly Effective
Overall		**3.84**	**0.93**	**Highly Effective**

Table 1 summarizes the expert respondents' evaluations of the effectiveness of the developed interactive science chatbot. It can be shown that the overall mean is 3.84 (SD=0.93), which points strongly agree. It manifests that the features of the evaluated chatbot are highly effective.

Teachers must always consider the effectiveness of a developed interactive science chatbot. According to Abbasi and Kazi (2014), in chatbot systems, user participation is more active during learning; user reflection and self-explanation may be encouraged, and many parallel channels and frontal communication are permitted. As per Fang (2016), language in science is an essential technology and plays an integral part in understanding the contents and topics of science. Chatbot's content should be presented engagingly and encourage them to express themselves in their native language. (Brandtzaeg et al., 2015). Teachers must meet Chatbots' primary purpose based on how it was developed, considering that the learners of today's generation are very independent and curious about how a material will help them to make their tasks easier. Furthermore, users expect a chatbot to answer questions, process requests, and orders and automate certain types of regimen, recurring, tedious communication interactions when interacting with it. Too complex chatbots with numerous features may be challenging for the user to understand, and they will prefer to use something simpler (Livingston & Flores, 2017).

2. Description of the Respondent's Self-regulated Learning Skills

Table 2
Summary of Learner Respondents' Description of Self-regulated Learning Skills

Skills	Number of Indicators	Mean	SD	Interpretation
Goal setting	10	4.21	0.38	Manifested
Self-monitoring	10	4.18	0.33	Manifested
Self-instruction	9	4.09	0.38	Manifested
Self-reinforcement	10	4.01	0.26	Manifested
Overall		**4.12**	**0.34**	**Manifested**

Table 2 summarizes the respondents' descriptions of their self-regulated learning skills. The overall mean is 4.12 (SD=0.34), which means strongly agree indicates that the respondents' self-regulated learning skills are manifested.

Setting goals is primarily intended to assist pupils in making practical efforts toward achieving them (Elias, 2019). Moreover, it is significant for the learners that they know to set their own goals, and it is a great help for them in realizing their learning. Manifestation of the setting of goals is also strongly related to student ability and accepting sudden changes. Suppose an educator could initiate well-planned activities and materials to support building the learners' confidence and acceptance. In that case, this will lead to a positive result which could help the learners' academic persistence. (McKenna et al., 2018). Individuals with high self-monitoring levels tend to monitor themselves. They are more concerned with

their achievements, particularly if they meet specific academic goals. On the other hand, learners with low self-monitoring skills exhibit behaviors such as honesty and naturalness in social interactions rather than internal feelings and behaviors (Arslantas & Kurnaz, 2017).

Since the learners rely on their resources, self-instruction will play its role. Learners tend to understand the content of learning materials based on how the phases were presented. It may provide an understanding of learner-direction's functionality, facilitated by various methods and devices. Self-reinforcement is a catching-on strategy that reinforces the association between sensory input and specific reactions. These naturally occurring reinforcers may not be enough to keep all students' desirable behaviors consistent. It is frequently necessary to seek out more potent reinforcers. Teachers should exercise caution when selecting and employing positive reinforcers.

Students' efforts to self-regulate their learning and critical motivators initiate, mediate, and sustain their learning efforts. In times when the learners are not in the comfort of a traditional classroom to learn and understand certain science concepts and skills, their self-regulation to learn plays a vital role.

3. Pre-test and Post-test Scores of the Respondents in the Grade 10 Science Competencies Test

Table 3
Respondent's Pre-test and Post-test Scores in Science 10 Competencies test

Score	Pretest	Posttest	Interpretation
41-50	3	4	Highly Competent
31-40	16	20	Competent
21-30	14	10	Moderately Competent
11-20	2	1	Fairly Competent
0-10	-	-	Incompetent
Total	**35**	**35**	

Table 3 shows respondents' pre-test and post-test scores in science 10 competencies test. According to the table, when the pre-test was administered, most learners scored "competent" or "moderately competent."

Based on the table presented, learners already have prior knowledge of the contents included for the third quarter in science 10 before implementing chatbot as a supplementary tool. Because spiral progression can be seen in the K–12 Science curriculum, as learners advance to the next grade level, they already have knowledge and understanding of the competencies that are catered from the grade level they completed. Additionally, a glimpse of the competency teachers may discuss at the next grade level may be tapped, determining why students achieve higher scores in the pre-test. Deveci et al. (2021) stated that chatbots could be a good option for increasing interaction and motivation, enabling learning based on individual differences, and mitigating loneliness and social isolation are all benefits of this program. The learners used the interactive chatbot once a week to supplement topics teachers could not discuss face-to-face due to time constraints. Because the chatbot's content focuses on issues that require verbal explanation and understanding of terminologies, learners may choose to continue or return to specific topics based on their satisfaction with what they have learned or what is still unclear to them.

After the learners used the developed interactive chatbot, an increase in the number of "highly competent" and "competent" learners was observed. At the same time, results achieved a decrease in the number of "fairly competent" learners. Researchers believe using chatbots in science education is essential

and will contribute to academic success because it will provide a setting in which students can learn to ask questions and continue to grow in their bravery (Deveci et al. (2021).

4. Level of Satisfaction in the Use of the Developed Interactive Chatbot in Science 10

Table 4
Summary of Respondent's Level of Satisfaction in the Use of the Developed Interactive Chatbot in Science 10

Skills	Number of Indicators	Mean	SD	Interpretation
Usage and content	10	4.33	0.46	Satisfied
Language used	4	4.32	0.56	Satisfied
Perception	5	4.00	0.52	Satisfied
Difficulties and limitations	7	2.50	0.44	Moderately Satisfied
Overall		**3.79**	**0.50**	**Satisfied**

Table 4 summarizes the respondents' satisfaction with using an interactive chatbot in science 10. It can be shown that the overall mean is 3.79 (SD=0.50), which means agree. This indicates that level respondents are satisfied with using an interactive chatbot in science 10.

Instruction is typically delivered as a narrative. The use of an interactive chatbot in this study focuses on how the teaching-learning process continues despite unexpected circumstances in a particular community. Satisfaction of learners with the developed material or supplementary tool must always consider.

To meet the learner's satisfaction, the usage and content of a developed material must always suit the level of their ability to understand and use the material whether they are alone or when they are with their colleagues. Consideration of the language about to be embedded in the material must also be observed. The level of language used also had a significant impact on the satisfaction of learners with using well-developed supplementary material.

Teachers should always prompt consideration of the diverse skills of this generation's learners in the delivery of the learning process. Using chatbots to evolve collaborative ideas would also be an effective way to connect with new educational chatbot supplementary tool possibilities (Jung et al., 2019).

5. Significant difference exists between the pre-test and post-test scores of the respondents in the Grade 10 Science competencies test

Table 5
Test of difference between the pre-test and post-test scores

Test	Mean	SD	t	Sig.
Pretest	30.63	6.76	5.122	.000
Posttest	33.14	7.17		

Table 17 shows the difference in the respondents' pre-test and post-test scores. The calculated t-value between the pre-test and post-test is 5.122, with a p-value lower than 0.05. As a result, there is a significant difference between the pre-test and post-test results. The result also implies that the chatbot was effective in assisting students in improving their performance on the science competencies test.

The interactive chatbot can be of great assistance to learners who are currently transitioning back to limited in-person classes. The language input of an interactive chatbot can be programmed based on its features and the

learners' level of understanding. Understanding inheritance and variation, particularly the interpretation of genetic coding and evidence of evolution, will be complicated for learners to grasp if they are alone. The learners' understanding of the topic improved due to the chatbot's code-switching features, as evidenced by their post-test results. Teachers can use it to improve students' interaction skills and assist them in automating processes (Veerasamy et al., 2019). Just like the situation of learners in Mabato National High School, there are instances when teachers fail to meet their learners on a face-to-face basis. A chatbot can be an alternative means of learning a specific topic and understanding its content. It can also be programmed to make it compatible with the learners' goal-setting skills and how they will monitor their respective accomplishments.

With the feature which learners readily access with or without data connectivity, monitoring learners' progress in a particular task can continue. The complexity of the developed interactive chatbot material was based on the learning delivery available to learners, specifically those that can be accessed using a mobile device and other learning devices suitable to the capability of the learners. To avoid learners waiting longer for responses due to a lack of data load, the researcher programmed the chatbot's content with fewer illustrations but with code-switching features. This feature can help learners study and comprehend the chatbot's content even when they are alone. When not in a traditional classroom setting, the development of interactive chatbots can increase learners' independence in exploring a to be given.

Conclusions

The following are the conclusions drawn from the study:

1. After the experts evaluated the chatbot supplementary material in terms of language, content, compatibility, and complexity, it showed that the developed chatbot supplementary material was “highly effective”.

2. The respondents' self-regulated learning skills are "manifested" in terms of goal setting, self-monitoring, self-instruction, and self-reinforcement.

3. It was observed that upon utilizing the developed interactive chatbot as a supplemental tool in teaching Science, an improvement in the learners’ post-test results was observed compared to their pre-test scores.

4. Based on the result of the collected data, the null hypothesis asserting that there is no meaningful change in the participant group's post-test and pretest total scores was not sustained.

Recommendations

The following recommendations are made based on the findings and conclusions:

1. Teachers may receive assistance from the school administration to participate in seminars or training related to the development of interactive chatbots and other instructional materials that may be used in hybrid learning.

2. Since the self-regulated skills were manifested in the respondents of this study, School Learning Action Cell (SLAC) Coordinator may consider including this as one of the topics in different areas.

3. Since the utilization of chatbots in teaching Science has an impact on the performance of the learner respondents, it is therefore suggested that it may utilize again in other classes in teaching Science. Moreover, additional features may be added, if possible, for the enhancement of the chatbot.

4. Teachers may consider crafting and using chatbots in other subjects. It has been effective in science, and it may be effective as well in other subjects. However, teachers who will be using may ask for assistance from the proponent of this study regarding preparations made and full implementation of the said chatbot.

5. Other effective strategies, aside from technology-based interventions, may be offered expressly for learners who do not have smartphones at home or who are enrolled in modular distance learning. Effective interventions can be provided based on the needs of the students.

References

Abbasi S and Kazi H. 2014. Measuring the effectiveness of learning chatbot systems on Student's learning outcomes and memory retention. *Asian Journal of Applied Science and Engineering, 3*, 57-66

Arslantas, S., & Kurnaz, A. (2017). the effect of using self-monitoring strategies in social studies course on self-monitoring, self-regulation and academic achievement. *International Journal of Research in Education and Science, 3*(2), 452-463.

Brandtzaeg, P. B., Haugstveit, I. M., Lüders, M., & Følstad, A. (2015). How should organizations adapt to youth civic engagement in social media? A Lead User Approach. *Interacting with Computers, 28*(5), 664–679. doi:10.1093/iwc/iwv041

DepEd Order No. 12. S. 2020. Adoption of the basic education learning continuity plan for the school year 2020-2021 in the light of the COVID-19 public health emergency. https://www.deped.gov.ph/2020/06/19/june-19-2020-do-012-2020-adoption-of-the-basic-education-learning-continuity-plan-for-school-year-2020-2021-in-the-light-of-the-covid-19-public-health-emergency/

Deveci Topal, A., Dilek Eren, C., & Kolburan Geçer, A. (2021). Chatbot application in a 5th-grade science course. *Education and Information Technologies, 26*(5), 6241-6265.

Elias, M. (2019). A framework for student goal setting. *George Lucas Educational Foundation*. https://www.edutopia.org/article/framework-student-goal-setting

Jung, H., Park, C. Y., Lee, J. J., & Pak, S. Y. (2019). A case study on development of mobile chatbot for promoting creative ideation. *The Journal of the Korea Contents Association, 20*(11), 2203-2210.

Livingston, K., & Flores, M. A. (2017). Trends in teacher education: A review of papers published in the European journal of teacher education over 40 years. *European Journal of Teacher Education, 40*(5), 551-560.

McKenna, B., Finamore, D., Hewitt, E. V., Watson, L., Millam, L. A., & Reinhardt, M. (2018). the effect of a multifactor orientation on student performance: Organizational skills, goal setting, orientation to classroom, and academic support. *Online Learning, 22*(4), 265-276.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in science education, 48*(6), 1273-1296.

Ursachi, G., Horodnic, I. A., & Zait, A. (2015). How reliable are measurement scales? External factors with indirect influence on reliability estimators. *Procedia Economics and Finance, 20*, 679-686.

Veerasamy, A. K., D'Souza, D., LindÃ, R., & Laakso, M. J. (2019). Prediction of student final exam performance in an introductory programming course: Development and validation of the use of a support vector machine-regression model. *Asian Journal of Education and E-learning, 7*(1).

Winne P.H. & Hadwin, A.F. (2010). Self-regulated learning and socio-cognitive theory. *Science Direct*. https://www.sciencedirect.com/topics/social-sciences/self-regulated-learning

Winkler, R. & Söllner, M. (2018). Unleashing the potential of chatbots in education: A state-of-the-art analysis. academy of management annual meeting (AOM). Chicago, USA.

Zimmerman, B. (2011). Investigating self-regulation and motivation: historical background, methodological developments, and future prospects. Clarivate.http://archive.sciencewatch.com/dr/erf/2011/11decerf/11decerfZimm

Copyrights