Yayla-Eskici, G. (2023). Evaluation of engineering design activities in science coursebooks in Turkey. *International Online Journal of Education and Teaching (IOJET), 10*(4). 2581-2595.

Received : 14.05.2023
Revised version received : 15.08.2023
Accepted : 19.08.2023

EVALUATION OF ENGINEERING DESIGN ACTIVITIES IN SCIENCE COURSEBOOKS IN TURKEY

Research article

Gamze Yayla-Eskici

gamze.yyl@gmail.com

Cumhuriyet University, Turkey

Biodata:

Gamze Yayla-Eskici, Ph.D., is a Research Assistant at Cumhuriyet University in Sivas, Turkey. Her research interests are Science Education, STEM, Science, Engineering and Entrepreneurship Implementations.

EVALUATION OF ENGINEERING DESIGN ACTIVITIES IN SCIENCE COURSEBOOKS

Gamze Yayla Eskici

gamze.yyl@gmail.com

Abstract

This study aims to evaluate the compatibility of engineering design activities in 5-8 grade science coursebooks in Turkey with the curriculum and to examine their reflection of design principles. The document analysis method was used in the study. Initially, the 5-8 grade science coursebooks recommended by the Ministry of National Education in 2021-2022 were determined. Then, the engineering design activities in these books and the learning outcomes related to engineering and design skills in the 2018 Science Curriculum were determined. As a data collection tool, an engineering design activity evaluation rubric based on engineering design principles was prepared by reviewing the relevant literature. Based on the prepared rubric, the activities in the science coursebooks recommended by the MoNE in 2020-2021 were examined. At the end of the examination, some learning outcomes had more than one engineering design activity, some learning outcomes did not have design activities, and some learning outcomes had design activities in subjects excluding the learning outcomes. Depending on this, the percentages of the coursebooks reflecting engineering design were determined. It was observed that the percentage of the coursebook with more STEM activities reflecting engineering design principles was low.

Keywords: engineering design skills, science coursebooks, design principles

1. INTRODUCTION

Science includes disciplines such as physics, chemistry, biology, astronomy, and many concrete and abstract concepts pertaining to these disciplines. In the science course, it is expected to teach scientific knowledge of these disciplines and ways of accessing knowledge (MoNE, 2018). An individual knowing the ways of accessing knowledge will be able to self-update his/her scientific knowledge. Therefore, various course resources are used to convey scientific content in science teaching. Coursebooks are the primary sources to reflect scientific knowledge regularly despite all technological developments. Even though different types of sources support coursebooks to access knowledge, the demand for coursebooks does not change thanks to the implementation of the curriculum, the examples it provides, the guidance it provides, and its easily accessible nature. Coursebooks are seen as essential for students to carry out the course in their study areas or with their teachers through a source (Tezcan, 2019). Considered a crucial element in the realization of curricula, coursebooks enable individual and social functions to be reflected in the classroom (Bayır & Kahveci, 2021). The MoNE examines the equipment of the coursebooks to be recommended to schools every year in terms of its regulations and the appropriate resources are distributed to all schools (Uçar & Somuncuoğlu, 2017). In this context, the Board of Education and Discipline has defined criteria for the evaluation of draft coursebooks. These criteria are: "*a. The conformity of the content with the Constitution and laws, b. The scientific adequacy of the content, c. The adequacy of the content to realize the learning outcomes of the education and training program, d. The visual design and content design to support learning and be suitable for the developmental characteristics of students* (MoNE BoED, 2019, pp. 3- 34)".

Coursebooks contain the scientific knowledge of the period they were written and the teaching methods of that period. In this regard, changes in scientific knowledge and new trends in teaching techniques cause curricula to be updated. In parallel with the changes in curricula, coursebooks are also being revised. Studies indicate that well-prepared and designed coursebooks increase students' comprehension of the coursebooks (Çakıcı & Girgin, 2012). Therefore, coursebooks need to be designed correctly to teach the knowledge and skills in the curriculum accurately. The science curriculum was also revised in terms of the skills and achievements it contains with the change made in 2018 (MoNE, 2018). The compatibility between the curriculum and the coursebooks arouses curiosity. From this perspective, it is seen that science books have been examined in terms of different variables in the relevant literature after the change. The content of the books was examined in terms of variables such as compatibility with inquiry-based learning approach, measurement and evaluation approach, scientist profiles, inquiry learning, cultural elements, chemistry concepts, analogies, graphic organizers, outcome-content relationship, mathematical content, physics examples (Deveci & Altıntaş,2022; Dinçer, 2019; Göksu & İnaltekin, 2020; Güneş, Sağdış & Şimşek, 2018; Güvendi, 2021; Kıvanç & Aydın, 2021; Köse, 2021; Köse, 2022; Nakiboğlu & Yıldırım, 2018; Ocak & Kocaman, 2018; Pektaş et al., 2022; Saka & İnaltekin, 2021; Sarıoğlan, Can and Gedik, 2016).

In the 2018 Science Curriculum, the change in field-specific skills is noteworthy. In addition to skill areas such as scientific process skills and life skills, engineering and design skills have been added. The engineering and design skills mentioned therein include the skills of making inventions and innovations and creating and presenting products by integrating science with mathematics, technology, and engineering (MoNE, 2018). Engineering design, as practiced by engineers, is a highly social and iterative process, for which there is often no single correct answer (Hauseholder & Hailer 2012). In the science curriculum, these skills are required to be acquired within the scope of science, engineering, and entrepreneurship practices. Within this context, students are expected to identify a problem that is open to the development of a tool, object, or system related to daily life related to the topics in the units. The problems should be evaluated well in terms of cost and time. They should also use promotional tools to market the products they will develop. At this point, the science curriculum for grades 3-8 includes science, engineering, and entrepreneurship practices from Grade 4 onwards. Related products are also expected to be presented at year-end festivals.

Science and engineering practices in the curriculum are not limited to identifying problems related to daily life within the scope of the unit, finding solutions to these problems, and preparing products. Engineering and design skills are also reflected in the curriculum learning outcomes. Starting from Grade 4, these skills are included as "design skills" in different units and subjects in the science course. The design mentioned here refers to the process of designing something. Designing and developing components, systems and processes is a creative, iterative and often open-ended process. Friesen, Taylor, and Britton (2005) defined design as the creative, open-ended and experiential components that characterize problem solving. There are also different learning outcomes aimed at developing different products such as a vehicle to reduce air and water resistance, a waste project for recycling solid waste and designing an imaging tool using mirrors and lenses (MoNE, 2018). In these learning outcomes, some designs are expected to be transformed into products, while some designs are expected to be expressed by drawing and converted into three-dimensional form if the conditions are suitable. The activities in the coursebooks that should reflect the engineering design skills in the curriculum at this point have been the subject of the relevant literature. Ecevit et al. (2022) examined the activities in 3rd and 4th-grade science books in terms of scientific process, life, and engineering skills and found them insufficient. Alın Uran (2019) examined the existing skills in all activities in secondary school science books. Similarly, Tezcan Şirin, Tüysüz, and Oğuz (2022) obtained teachers' opinions on the suitability of the activities in science books for STEM (Science, Technology, Engineering, and Mathematics) and found that teachers stated that the activities were related to real life but not suitable for STEM activities. Karabolat, Atıcı, and Taflı (2021) examined the activities in high school coursebooks in terms of achievements and STEM content and found that STEM-related activities were limited and few. Koyunlu Ünlü and Şen (2018) examined the 5th-grade science coursebook according to scientific research and engineering design steps and found that the activities did not include any design process steps. It shows that science textbooks are also examined in the international literature for similar reasons. Papakonstantinou and Skoumios (2021) examined the science and engineering schools in the secondary school textbooks and moved away from the low level of the books of this period. The study, in which science books were examined in terms of inquiry learning, found the inquiry results of their books to be successful in general (Aldahmash, Mansour, Alshamrani & Almohi, 2016; Lim, 2020). It is included in the related literature that science books examine according to the STEM and STEM education approach, which has been very popular recently (Aljalla & Alshamrani, 2020; Wang, Ma, Ling & Wang, 2021). In these studies, it is seen that the books use science the most when doing STEM integration, they are more outside of the science discipline, and they emphasize the structures of connections.

Examinations of engineering and design skills in science coursebooks cover content such as determining the type of skill in the activity, determining the relationship between the outcome and the content, and determining the compatibility of engineering design with STEM. Studies investigated how the engineering design specified in the curriculum was included in the books, and it was seen that they evaluated the skill content in all activities, not the quality of the design steps. Having activities suitable for engineering design does not mean that they will include all design steps. When it comes to engineering design, there must be a factor that allows redesigning when the design is not suitable for the solution. Or, when similar design principles are missing, the learning outcome of that skill will not reach its goal. Only Koyunlu et al. (2018) included engineering design steps in their study, but they analyzed only the 5th-grade book and found that engineering design steps were not included in the activities. This situation brings to mind how the engineering design in the activities changes as the grade level progresses. Moreover, all of the studies focused only on the engineering design of the activities and ignored the learning outcomes in the curriculum. Situations like "What are the learning outcomes allowing students to design? Are there activities for those learning outcomes? If so, are these activities appropriate for the design steps? Are there any engineering design activities that are not related to the learning outcomes?" related to the compatibility of the book and the curriculum were not clarified.

The changes made in the science curriculum concerning science and engineering applications can be implemented through coursebooks. As stated in the criteria of the Board of Education and Discipline; a coursebook should be arranged in a way that its knowledge content is scientifically adequate as well as being adequate in achieving the learning outcomes in the curriculum. For this reason, the interdisciplinary process emphasizing the interaction between science and engineering should be reflected in science coursebooks. Furthermore, it is important to include activities related to science and engineering skills in the unit and learning outcomes in the coursebook in which engineering design skills are included in the curriculum.

The study aims to examine the compatibility of engineering design activities in science coursebooks with the curriculum and their reflection of design principles. In line with this purpose, answers to the following questions will be sought:

1. What is the distribution of engineering design activities related to the learning outcomes in the Science Curriculum according to grade and subject?
2. What is the distribution of activities that are not related to the learning outcomes in the Science Curriculum according to grade and subject?

3. What is the rate of reflection of engineering design principles in science coursebooks?
4. What is the rate of inclusion of engineering design principles in all activities?

2. METHOD

This research examined the activities in the 5th, 6th, 7th, and 8th-grade science coursebooks being implemented in the 2020-2021 academic year in the context of engineering design principles and the 2018 science curriculum in Turkey. The document analysis method was used in the research. Document analysis involves the analysis of written materials that contain information about the phenomena or events targeted for research (Yıldırım & Şimşek, 2006). Written sources can be books, journals, edicts, memoirs, or articles (Sönmez & Alacapınar, 2016). Since the 5-8 grade coursebooks recommended by the Ministry of National Education were used as the source, the method is document analysis.

2.1. Data Collection and Data Analysis

The following steps were followed while conducting this research examining the compliance of engineering design activities with design steps and curriculum learning outcomes.

1. Books recommended by MoNE were determined (Table 2).
2. Engineering design learning outcomes in the science curriculum were determined. For this purpose, two academicians specialized in science education were consulted and a consensus was reached on the learning outcomes.
3. Engineering design activities in each proposed book were determined. Similarly, in determining the activities, the opinions of two academicians specialized in science education were taken and a consensus was reached.
4. The activities were grouped as relevant and irrelevant to the learning outcome.
5. An evaluation rubric for engineering design activities was prepared by examining the literature on engineering design and utilizing Volkmann & Abell's (2019) inquiry-based activity evaluation rubric. The rubric was reviewed and edited by field experts for content validity (Table 1).
6. All activities were evaluated with the activity evaluation rubric.
7. The contents of the engineering design activities in some books did not include content describing the design steps. For this reason, to determine the accuracy and quality of the design steps in the books, the instructions on engineering design principles at the beginning of the books were also evaluated according to the rubric.
8. While evaluating the activities, if the instructions were referred to, the percentage of instructions was taken into consideration.
9. The frequencies of each design principle were determined to identify the percentage of the activities and therefore the books reflecting engineering design principles.
10. The findings were presented in tables.

Table 1. Evaluation rubric for engineering design activities

Principles	**Content**	**Control**	**Yes**	**No**
Defining the need or problem	*Generating leading ideas by asking questions to define the problem*	Does the engineering design start with a real-life-based question, problem, or need?		
Conducting problem-oriented research	*Forming pioneering ideas*	Does it allow for researching existing solutions, collecting experimental data, or brainstorming alternative solutions?		
Developing possible solutions	*Drafting the draft report*	Is the information obtained evaluated and preliminary reports on the subject asked to be prepared?		
Choosing the best solution	*Preparation of decision matrices*	Does it lead to the best design by ignoring some criteria?		
Preparing a prototype	*Making the first design*	Is it requested to make a design to visualize the design, to reveal the details?		
Testing the solution	*Evaluations in terms of both problem-solving and material usability and cost*	Is there any testing and evaluation of the success of the design?		
Conveying the solution	*Inquiry and sharing before a redesign*	Is it requested to share the rationale for the decision?		
Redesign	*Making improvements*	Does it allow for redesign until scientific satisfaction with the design?		
Final design	*Presenting the product*	Is it requested to share the final, improved version of the design?		

As mentioned above, the books in which engineering design activities were evaluated are shown in Table 2. In this context, a total of 7 books were analyzed: two books from 5th grade, two books from 6th grade, two books from 7th grade, and one book from 8th grade. Two researchers carried out the analysis of the activities individually. The evaluators, including the author, were experts in the field of science education. For reliability, the formula reliability=(agreement)/(agreement+disagreement) was used (Miles & Huberman, 1994: 64). The consistency between the researchers was calculated as 92%. In the presentation of the findings, the researchers discussed and reached a consensus.

Table 2. Science coursebooks recommended by the Ministry of National Education and publishing houses

Grade	Publishing houses	Authors	Abbreviation	No. of activities
5	Ministry of National Education publication SDR Dikey publishing	Seval Akter, Hatice Betül Arslan, Meltem Şimşek Erdem Ünver, Murat Volkan Yancı, Zafer Arslan	MEB DİKEY	9 3
6	Ministry of National Education publication Ministry of National Education publication	Semra Demirçalı, Birsen Alkan Fatih Serdar Yıldırım, Ali Aydın, İhsan Sarıkavak	MEB MEB II	8 5
7	Ministry of National Education publication Tutku publishing	Ertan Akdemir, Dilek Çetin Atasoy Ayşe Seyrek, Sümeyra Türker, Tuğba Bozkaya, Zühre Üçüncü	MEB TUTKU	8 6
8	SDR Dikey publishing	Murat Volkan Yancı	DİKEY	8

3. FINDINGS

The findings obtained by analyzing the activities in the 5th-8th grade science coursebooks taught in the 2020-2021 academic year in terms of both learning outcomes and design principles are presented in the tables. The findings were tabulated separately according to the problem of the research.

Table 3. Learning outcomes and related activities related to engineering design

Grade	Subject	Learning outcome	Activity page numbers			
			MEB	MEB II	DİKEY	TUTKU
	Measurement of force	Designs a dynamometer model using simple tools and equipment	86		67	
5	Friction force	Generates new ideas to increase or decrease friction in everyday life	103			
	Structure and properties of the sun	Designs a model to compare the size of the sun with the size of the earth			18, 34	
6	Matter and Heat	Develops alternative thermal insulation materials	136,145	123		
	Interaction of sound with matter	Designs an environment that will serve as an example of sound insulation or acoustic applications.		172		
	Energy transformations	Designs a means to reduce the effect of air or water resistance	100			96
	Particle structure of matter	Creates and presents various molecular models	114			111
7	Refraction of light and lenses	Designs an imaging tool using mirrors and lenses	176			184
	Connection of the bulbs	Designs an original lighting tool	216			233
	Household waste and recycling	Designs a project on recycling domestic solid and liquid wastes	137			139
	Space exploration	Presents by preparing a simple telescope model	27			28
	Simple machines	Designs a device that will provide ease of work in daily life by using simple machines			176, 180	
8	Electric energy conversion	Designs a model based on the conversion of electrical energy into heat, light, or motion energy			222	
	Sustainable development	Designs a project for the economical use of resources				

In Table 3, the activities related to the engineering design learning outcomes given according to grade levels are shown according to the page numbers in the science books recommended by the Ministry of National Education. When Table 3 is examined, it is seen that there are a total of 14 engineering design learning outcomes in the science curriculum, three in 5th grade, two in 6th grade, six in 7th grade, and three in 8th grade. It is seen that there is no activity for the eighth-grade engineering design learning outcome on sustainable development. Similarly, it is seen that only one of the recommended coursebooks contains activities for engineering design learning outcomes on the subject of friction force and the structure and properties of the sun in the 5th grade and on the interaction of sound with matter in the 6th grade. In addition, it is noteworthy that some of the recommended books on the subjects of the structure and properties of the sun in Grade 5, matter and heat in Grade 6, and simple machines in Grade 8 contain two design activities for the same learning outcome.

Table 4. Engineering design activities unrelated to the learning outcomes in the curriculum

Grade	**Subject**	**Activity page numbers**			
		MEB	**MEB II**	**DİKEY**	**TUTKU**
5	Sun, Earth, and Moon	44			
	The world of living things	71			
	Measurement of force	109			
	Matter and change	155			
	Propagation of light	200			
	Human and environment	241			
	Electric circuit elements	265			
6	Solar system and eclipses	39	23		
	Systems in our body	81	62		
	Force and Motion	105			
	Sound and Properties	161			
	Health of systems	192	214		
	Transmission of electricity	224			
7	Solar system and beyond	36			
	Cell and divisions	51			
8	Seasons and climate			31	
	DNA and the genetic code			72	
	Pressure			94	
	Matter and industry			152	
	Electric charges and electric energy			253	

When the learning outcomes in the science curriculum were examined, activities that were unrelated to the learning outcomes involving engineering design were found (Table 4). In this context, it is seen that there are 7 engineering design activities in the MEB publication for the fifth grade. However, in the other recommended book for the 5th grade, Dikey Publishing, such a situation was not observed. In the sixth grade, there are 6 engineering design activities in the MEB publication and 3 in the MEB II publication. In the seventh grade, there were 2 engineering design activities in the MEB publication, while the other recommended book, Tutku Publishing, did not have such a situation. In the eighth grade, the only recommended book, Dikey Publishing, has 5 engineering design activities outside the learning outcomes.

Table 5. Percentages of activities in the books reflecting engineering design principles

Grade	MEB		MEB II		DİKEY		TUTKU	
	%	Level	%	Level	%	Level	%	Level
5	56	Low			55	Low		
6	76	Good	57	Low				
7	68	Medium					71	Good
8					61	Medium		
Average	67	Medium	57	Low	58	Low	71	Good

The activities given in Table 3 and Table 4 were evaluated according to the rubric prepared and it was revealed to what extent the engineering design activities reflected design skills. Accordingly, when Table 5 is analyzed, it is seen that the book that best reflects engineering design belongs to the 6th grade MEB publication (76%). The book with the activities that reflect engineering design the least is the 5th-grade Dikey publication. The percentages reflecting design principles between 50-60 were considered low, between 60-70 were medium, between 70-80 were good, and above 80 were considered excellent. The fact that the books generally reflect the design principles between 50-70% shows that they are at low and medium levels in terms of engineering design. This finding is more evident when looking at the average percentages.

Table 6. Percentages of engineering design guidelines reflecting design skills

Grade	Percentage reflection of engineering design principles			
	MEB	MEB II	Dikey	Tutku
5	67		89	
6	78	89		
7	78			89
8			78	
Average	74	89	83	89

In the instructions section of science coursebooks, it was observed that there were also instructions such as engineering design stages or design principles in addition to instructions such as the use of the book, and scientific method steps. In some activities, the relevant instructions were used to direct the students to organize the given design according to the written steps. Therefore, the percentages of the instructions reflecting the principles of engineering design were analyzed and the source of the average percentages of the books was inquired. When Table 6 is analyzed, it is seen that the instructions do not meet each of the design skills. It is seen that the instructions that best reflect the principles of engineering design are 5th-grade Dikey publishing, 6th-grade MEB II publication, and 7th-grade Tutku publishing. When the average ratios are analyzed, it is seen that the instruction(s) that reflects the most is Tutku publishing and the instruction that reflects the least is MEB.

Table 7. Ratios of engineering design skills in activities

Principles	Content	Frequency
Defining the need or problem	*Generating leading ideas by asking questions to define the problem*	15
Conducting problem-oriented research	*Forming pioneering ideas*	36
Developing possible solutions	*Preparation of the draft report*	35
Choosing the best solution	*Preparation of decision matrices*	15
Preparing a prototype	*Making the first design*	46
Testing the solution	*Evaluations in terms of both problem-solving and material usability and cost*	40
Conveying the solution	*Inquiry and sharing before a redesign*	0
Redesign	*Making improvements*	40
Final design	*Presenting the product*	45

The frequencies of each design principle in the activities were determined to see the sources of the percentages of reflection of engineering design principles in science coursebooks (Table 7). Considering that there were 46 activities in total, it is seen that the principles of preparing prototypes, presenting the product, testing the solution, and redesigning the product were the most frequently included principles. The principles of defining the problem and selecting the best solution were found the least, while the principle of conveying the solution was ignored in all activities.

DISCUSSION AND CONCLUSION

In this article, 37 engineering design activities were evaluated in total in the secondary school 5-8th grade science coursebooks recommended by the Ministry of National Education in the 2020-2021 academic year. In total 37 activities were evaluated in this study. The activity evaluation revealed both the compatibility between the curriculum and the books and the extent to which an activity given as an engineering design activity achieved its purpose.

As stated in the criteria of the Board of Education and Discipline, a coursebook should be designed in a way that its knowledge content is not only scientifically adequate but also adequate in achieving the learning outcomes in the curriculum. From this perspective, it is essential to see the application of the engineering design outcomes in the curriculum in coursebooks. However, the results obtained in the study show that the situation is missing in this respect. While only 7th-grade coursebooks include activities pertaining to engineering design learning outcomes, this is not the case for the other grades. Remarkably, there are no activities related to any of the learning outcomes in the 8th grade MEB publication. Some coursebooks do not include an activity for one outcome but include two activities for the other outcome. For example, this situation is observed in 5th-grade Dikey publishing. Due to all these reasons, it shows that engineering design and related learning outcomes, emphasized in the curriculum except for 7th grade, are incompatible with the coursebooks. Similarly, Koyunlu et al. (2018) included engineering design steps in their study, but analyzed only the 5th-grade coursebook and found that engineering design steps were not included in the activities. Based on the results, in terms of the compatibility between engineering design and coursebooks, engineering design practices will be given more space when MEB for 5th grade, MEB for 6th grade, MEB for 7th grade, and Dikey publications for 8th grade are used.

In the study of Ocak and Kocaman (2018), the harmony between the contents of science textbooks and their achievements was examined and it was seen that the books were compatible in this respect. Contrary to this study, It was observed that there are engineering design activities in the coursebooks that are not related to the learning outcomes of the science curriculum. In the examinations conducted on this issue, it was observed that Grade 7 did not include many activities outside the learning outcomes. Thus, it can be said that Grade 7 science coursebooks are the most compatible grade level with the curriculum for engineering and design activities. Although the 5th and 6th grades had missing activities related to the learning outcomes, many activities were not related to the learning outcomes. This situation shows that different engineering design activities were reflected in the books by ignoring the learning outcomes in the curriculum. It can be said that this situation will negatively impact the effect of the curriculum in practice.

All learning outcomes both related and unrelated to engineering design in the science curriculum were evaluated through a rubric. The related activities were scored and their percentages reflecting design principles were determined. According to the results obtained, although there were more activities in the MEB books, the percentages of the activities were lower. Although they stood out in terms of having more activities, they fell behind in terms of content. In this respect, while MEB publications stand out in terms of quantity, the situation varies according to grade levels in terms of quality.

When inquiring about the reasons for the low rate of reflection on engineering design skills, this may be due to the instructions at the beginning of the books. In some science coursebooks, only the problem and design (product) are required, and there are no additions about what needs to be done in the meantime. However, in the science curriculum it is stated that;

> *"This field includes the integration of science with mathematics, technology, and engineering, an interdisciplinary approach to problems, bringing students to the level of invention and innovation, enabling students to create products using the knowledge and skills they have acquired, and developing strategies on how to add value to these products" (MoNE, 2018, p.10).*

The steps and instructions given during the activity are very important for reaching the level of invention and innovation. This situation can be considered more important, especially for secondary school students who are still gaining new experiences in the name of engineering. Hence, when the relevant instructions are used in the activities, the deficiencies in the instructions may be reflected in the stages of the activity. Each engineering design principle was also analyzed separately to understand which design steps this situation, affecting the percentages of design elements in the books, belongs to. Considering the importance of starting from a problem in daily life in engineering design, the fact that the most important design principle in the activities, like identifying the problem, was found to be quite low is a negative situation. The engineering design process usually involves identifying the criteria and limitations of the problem, brainstorming possible solutions, building a prototype for the selected solution, testing the prototype, and repeating the previous steps (NRC, 2012). Drawing prototypes also drew attention to the scarcity of decision matrices in which students are guided on how to choose the best solution. After the student's research, the elements such as cost, etc. must be given in advance to guide the design. After testing the design, it is necessary to determine why the design failed before proceeding to redesign. In this context, when there is no principle of conveying the solution, it will not be seen which deficiencies will be addressed when redesigning. It is also noteworthy that this stage is not included in all activities. Similarly, in some studies, it has been revealed that science books are not suitable for the purpose of STEM activities and the activities are few (Karabolat et al., 2021; Tezcan Şirin, 2022).

RECOMMENDATIONS

1. Including the missing engineering design outcomes in the science curriculum in the coursebooks,
2. Engineering design activities should start with an attention-grabbing problem that will encourage students to research instead of just directing them to design,
3. While there is no single way to conduct engineering design activities, review the activity guidelines for testing and checking the prototype built and preparing decision matrices on how to guide the design,
4. Paying attention to the compatibility between learning outcomes and activities when determining coursebooks,
5. Since the activities that are not seen to be related to the learning outcomes in the science coursebook may prevent the curriculum from achieving its goals, program preparers and book authors should pay attention to this situation,
6. Considering that a high number of activities is not enough to increase the percentage of reflection on engineering design and that the reflection of design principles is low in coursebooks with a high number of activities, it can be suggested as a result of the study to give importance to the quality of content instead of the number of activities.

REFERENCES

Aldahmash, A. H., Mansour, N. S., Alshamrani, S. M., & Almohi, S. (2016). An analysis of activities in Saudi Arabian middle school science textbooks and workbooks for the inclusion of essential features of inquiry. *Research in science education,* 46, 879-900.

Alın Uran, G. (2019). *Classification of activities in science textbooks in terms of field-specific skills* (Unpublished Master's Thesis). Hacettepe University, Institute of Educational Sciences, Ankara.

Aljallal, M. A., & Alshamrani, S. M. (2020). Developing and Teaching Science Textbooks' Content According to STEM Education Approach: The Centralized Educational System Context. Proceeding of the 2020 NARST Annual International Conference. Portland, OR.

Bayır, E., & Kahveci, S. L. (2021). Analysis of secondary school science textbooks in terms of readability. *Trakya Journal of Education, 11*(3), 1561-1572.

Bostan Sarıoğlan, A., Can, Y., & Gedik, İ. (2016). Evaluation of the appropriateness of the activities in the 6th grade science textbook to the inquiry-based learning approach. *Abant İzzet Baysal University Journal of the Faculty of Education, 16*(3), 1004-1025.

Çakıcı, Y. & Girgin, E. (2012). Primary Education II. Examining the end-of-unit evaluation questions in the secondary school science and technology textbooks. *Journal of Erzincan University Faculty of Education, 14*(2), 87-110.

Deveci, İ., & Altıntaş, A. (2022). Investigation of 2019 Science Textbooks in Terms of Assessment and Evaluation Approaches. *Journal of Erzincan University Faculty of Education, 24*(1), 31-45.

Dinçer, N.B. (2019). *Examining the activities in the primary school 4th grade science textbook* (Unpublished Master's Thesis). Trakya University, Institute of Social Sciences, Edirne.

Ecevit, T., Alagöz, s., Özkurt, N., & Köylü, Ü. K. (2022). Examining the activities in primary school 3rd and 4th grade science textbooks in terms of gaining scientific process, life and engineering design skills. *Trakya Journal of Education, 12*(2), 743-758.

Friesen, M., Taylor, K. L., & Britton, M. G. (2005). A qualitative study of a course trilogy in biosystems engineering design. Journal of Engineering Education, 94(3), 287-296.

Göksu, V., & İnaltekin, T. (2020). Examining the profiles of scientists in secondary science textbooks in Turkey. *Kastamonu Journal of Education, 28*(2), 977-991.

Givendi, M. F. (2021). Examination of Cultural Elements in Primary School Science Textbooks. *Journal of Values Education, 19*(42), 9-37.

Güneş, Y. İ., Sağdıç, F., & Şimşek, C. L. (2018). Determining whether the activities in secondary school science textbooks support inquiry-based learning. Journal of Multidisciplinary Studies in Education, 2(2), 28-38.

Householder, D. L., & Hailey, C. E. (2012). Incorporating engineering design challenges into STEM courses. Publications. Paper 166.

Karabolat, B., Atıcı, T., & Taflı, T. (2021). Examining the achievements and activities in the biology course curriculum and textbooks according to the stem approach. *Mehmet Akif Ersoy University Journal of the Faculty of Education,* (58), 645-670.

Kınavç, Z., & Aydın, A. (2021). Determination of Analogies for the Chemistry Concepts in the 7th Grade Science Textbook. *Journal of the Turkish Chemical Society, Section C: Chemical Education, 6*(1).

Koyunlu Ünlü, Z., & Şen, Ö. (2018). Examining the activities in the 5th grade science textbook according to the scientific research and engineering design process. *Sakarya University Journal of Education, 8*(4), 185-197.

Köse, M. (2021). Analysis of Secondary School Science Textbooks in terms of Measurement and Evaluation. *Erzincan University Journal of Education Faculty*, *23*(2).

Köse, M. (2022). Evaluation of Analogies in Science Textbooks. *Cumhuriyet International Journal of Education*, *11*(1), 112-126.

Lim, S. (2020). Analysis of Teaching Strategies, Types of Inquiry Activities and the Relationship between Inquiry Activities and Concepts Presented in Elementary School Science Textbooks-Focusing on Earth Science. *Journal of Korean Elementary Science Education, 39*(3), 449-463.

Miles, M.B. ve Huberman, A.M. (1994). *Qualitative data analysis. Thousand Oaks*, CA: Sage.

Ministry of National Education Board of Education and Discipline [MEB TTKB]. (2019). The criteria and explanations that will be the basis for evaluation in the examination of the draft textbook and educational tools and their e-contents. Ankara: MEB.

Ministry of National Education (2018). Primary education institutions (primary and secondary schools) science lesson (3, 4, 5, 6, 7 and 8th grades) curriculum. Ankara.

Nakiboğlu, C., & Yıldırım, Ş. (2018). Examining the use of graphic organizers in secondary school science textbooks. *Journal of Theoretical Educational Science,* 1-23.

National Research Council [NRC]. (2012). *A Framework for k-12 science education: practices,* crosscutting concepts, and core ideas. Washington DC: The National Academic Press.

Ocak, G. & Kocaman, B. (2018). Evaluation of the relationship between achievement and content in the primary school science curriculum. Ondokuz Mayis University Journal of Education Faculty, 37(2), 1-14.

Papakonstantinou, M., & Skoumios, M. (2021). Science and engineering practices in the content of Greek middle school physics textbooks about forces and motion. Journal of Technology and Science Education, 11(2), 457-473. https://doi.org/10.3926/jotse.1286

Pektaş, M., Sadak, m., İncikabı, l., & Kayabaşı, b. (2022). Examining the mathematics content of science textbooks: Linked textbooks. *Mehmet Akif Ersoy University Journal of the Faculty of Education,* (61), 98-121.

Saka, T. & İnaltekin, T. (2021). Comparison of Physics Examples in Science Textbooks. *Van Yüzüncü Yıl University Faculty of Education Journal, 18*(2), 81-110.

Sönmez, V. ve Alacapınar, F. G. (2016). *Scientific research methods*. Ankara: Memoir Publishing.

Tezcan, G. (2019). *Examining the compatibility of the activities in the secondary school science textbooks with science, technology, engineering and mathematics approaches and teachers' opinions* (Master's Thesis). Van Yüzüncü Yıl University, Institute of Educational Sciences, Van.

Tezcan Şirin, G., Tüysüz, M., & Oğuz, E. K. (2022). Teachers' views on the suitability of activities in secondary school science textbooks with STEM activities. *Van Yüzüncü Yıl University Journal of the Faculty of Education*, *19*(Special Issue), 354-386.

Uçar C. & Somuncuoğlu, D., (2017). Evaluation of secondary school 5th grade science textbook in terms of visual design principles, *Kastamonu Education Journal 25*(4), 1373-1388.

Volkmann, M. J., & Abell, S. K. (2003). Rethinking laboratories. *The Science Teacher*, *70*(6), 38.

Wang, T., Ma, Y., Ling, Y., & Wang, J. (2021). Integrated STEM in high school science courses: an analysis of 23 science textbooks in China. *Research in Science & Technological Education,* 1-18.

Yıldırım, A. ve Şimşek, H. (2006). *Qualitative research methods in the social sciences*. Ankara: Seçkin.