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# Evaluation of Nature-Integrated STEM Activities from the Students' Perspectives

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**ABSTRACT**

This study aims to evaluate the courses designed using the STEM approach, which combines nature-based learning environments with informatics from students' perspectives. Under the scope of nature-based courses, some activities integrated into "Drama, Biomimicry, Ecoprint, Basic Electricity, Metamorphosis, and Bridging Science" were conducted for 10 days. Following, a part of technology-integrated courses such as "Digital Storytelling, Algorithm and Augmented Reality/Visual Block Programming" were instructed to students and employed to perform STEM activities by getting the inspiration of the courses. Then the views of 37 middle school students who participated in the courses were collected using a semi-structured form of qualitative data collection tools in four categories: Preparation, Instructional Material, Process, and Contribution. The data were analyzed by categorical content analysis, and the findings related to each subcategory, concept, and code for each category were presented in tables. To increase coding reliability, the opinions of two field experts and a measurement and evaluation expert were consulted. A Consensus was reached with another expert, resulting in a 95% agreement. According to the study results, the students generally express positive opinions on the courses. They stated that courses and game-based lessons that are based on learning by doing and experiencing are more interesting, and that the combination of nature-based learning and information technology is an important experience for them.

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## INTRODUCTION

In today's conditions, almost every household has some type of computer. As a result, today's children are using smartphones, tablets, and laptops from an early age. Starting with acquiring basic computer skills at an early age, this process is directed towards homework, study, research, designing and producing various projects by the time they reach school age. These devices, which are mostly used as an entertainment tool for secondary school students, are increasingly directed towards research and production courses at the request of parents and teachers at a later stage. It is a visible fact that these initiatives, whose success has not yet been proven, are essential in today's world (Önür and Kozikoğlu, 2020; Mısırlı, 2015).

Haddon (2004) emphasis that in a world surrounded by smart devices, the importance of computer science is becoming increasingly apparent every day. Computer has become a fundamental skill, just like reading and writing. Being competent in these skills is becoming increasingly important to succeed in daily and work life. In such a world equipped with smart devices, we need to have these essential skills to maintain our daily lives. Most individuals must interact and communicate with these devices while meeting their basic needs. For instance, individuals who do not know the language of smart devices and cannot communicate with them experience difficulties maintaining their daily lives and will face even more difficulties in the future (Tamilselvan, Sivakumar & Savukan, 2012).

The speed of technological developments is causing our daily lifestyle to change rapidly. Many people prefer to order their basic needs from their homes instead of going to a store while shopping. Nowadays, the internet is not a separate world spent in special times, but it has become an integrated concept in our lives. Being online means being online in life. Therefore, using smart devices only to communicate, understand their language, and stay in communication with them has become a standard skill for today, and using these devices for production purposes has become important. To use these devices for production purposes, one must have coding or programming knowledge, which is their native language. Resnick & Siegel (2015) describe coding as a new type of literacy and personal expression, rather than a series of technical skills that are important for everyone, like learning how to write.

Science education has been frequently accepted as an inseparable and extremely important part of comprehensive schooling, research studies of the last few decades confirm such a position (Lamanauskas, 2013). Natural science’s importance is indubitable. The Rapid spread of scientific cognition inevitably raises new challenges for natural education, the penetration into educational environments is intensive induces to re-evaluate of generally used education strategies and technology-science integration.

### The role of Informatics in education

In developing education systems for educating individuals with 21st-century skills, education has started to be given more importance in line with the demands of the industrial sector and the future predictions of economists (Kasalak & Altun, 2020). It is thought that the current demands of the industry will be met with STEM education that allows interdisciplinary applications. The US government has realized it will lag behind other countries economically due to the increasing number of countries trying to gain global market share in economic activities (Tuğluk & Öcal, 2017). Considering that an increase in the number of professionals in STEM disciplines is needed to catch up with innovations and technological developments, it has included the STEM discipline in educational curricula.

In addition to STEM education, the importance of programming knowledge and skills for the global revival of a country is emphasized. Having programming knowledge is a driving force for preparing the workforce of the future for the information technology industry and all other areas, allows students to be the creators of innovation, and the knowledge and skills gained by learning computer programming are 21st-century skills that everyone needs to learn today (Popat & Starkey, 2019).

Computer science and coding skills are widely regarded as valuable in the current and predicted job market (Zinth, 2015). In today's world, coding education equips individuals with the necessary skills and equipment to survive, and coding education is important in adapting to society’s current needs. Therefore, coding education is included in the curricula of many countries such as the US, the UK, Belgium, and Spain (Okal, Yıldırım, & Temur, 2020).

Many studies show that integrating computer science supports creative and critical thinking. These studies provide suggestions for integrating computer science into the education system. Computer science allows students to see themselves as passive consumers of technology and as active producers and inventors of technology beyond coding (Çiftçi & Bildiren, 2020). In general, the literature suggests that students use many skills beyond coding when learning to code. These skills can be further developed by incorporating them into a planned instruction or curriculum (Popat & Starkey, 2019). However, by its very nature, programming is a difficult process. Especially at a young age, it is considered more challenging to teach because it requires abstract thinking skills. Recognizing the importance of acquiring these skills early, researchers have designed various environments where young children can easily learn programming. The best example of this is the Scratch visual block-programming environment developed at the Massachusetts Institute of Technology (MIT). Visual programming environments are a good starting point for students of all ages with no programming background (Çiftçi & Bildiren, 2020). The development of Scratch has enabled many studies on teaching coding at an early age. Many countries are conducting studies to provide coding education to students easily. Therefore, countries have facilitated the creation of different programming environments such as "code.org, Scratch, and MBlock" and integrated them into their curricula (Okal, Yıldırım & Temur, 2020).

**STEM and robotic coding**

Although many studies support the inclusion of computer science courses in K-12 education, some students perceive computer science as boring, complex and difficult to master (Çiftçi & Bildiren, 2020). In addition to visual block programming environments, various robotic tools are used to make coding learning more fun and relatively more concrete. Robotic tools, especially popular with the STEM education movement, help students assimilate STEM concepts (Horizon Report, 2016).

STEM, technology-integrated learning topics such as computational thinking, computer science education, robotics, and coding, enable children to engage in problem-based courses by designing robots and writing computer code (Çiftçi & Bildiren, 2020). Research indicates that including robotics in early childhood education environments effectively increases and supports interest in STEM learning (Horizon Report, 2016). According to Eguchi (2017), educational robotics is an effective learning tool for project-based learning in which STEM, coding, computational thinking, and engineering skills can all be integrated into a single project. Studies show that integrating STEM concepts and practices leads to increased conceptual learning across disciplines and supports gains in engineering and technology (Gencer, Doğan, Bilen, & Bilge, 2019).

It is understood that combining STEM education and coding education makes abstract concepts concrete, and leads to permanent, meaningful, and in-depth learning (Avcı, Okuşluk, & Yıldırım, 2021). Robotic sets are essential tools that enable the integration of STEM and coding. Considering the goals of STEM literacy education, it is thought that robotic tournaments, in particular, can have a positively impact students' coding skills and direct them from being consumers to producers in their future lives (Dönmez, 2017).

While robotics offers students opportunities to discover how technology works in real life, it also allows them to find new ways of working together to develop collaboration skills and express themselves using technological tools, problem-solving, and critical and innovative thinking. Most importantly, educational robotics provides a fun and exciting learning environment due to its applied nature and technology integration (Greca Dufranc, García Terceño, Fridberg, Cronquist & Redfors, 2020). Governments that recognize these advantageous aspects of robotics and STEM are developing STEM education strategies that prioritize the inclusion of robots and robotic courses and trying to integrate them into their curricula. In some schools in Singapore, robotics has become an integral part of the applied STEM curriculum; similarly, camps held at Arizona State University aim to increase girls' interest in STEM by teaching them the basics of robotics coding. While the Queensland government in Australia recently made it mandatory to add robotics to school curricula, the South Korean government has launched a program that opens new horizons by teaching students English through robots (Horizon Report, 2016). In many countries, STEM and robotics activities are organized in out-of-school learning environments such as summer camps and after-school courses, as in our country. Whether in-school or out-of-school activities, learning by doing and experiencing brings the active learning process, which is called the learning process in which students are forced to use their mental abilities through complex activities by taking responsibility for learning, and are offered decision-making and self-regulation opportunities (Açıkgöz, 2008). According to Harmin and Toth (2006), students who are supported with STEM-based robotic activities in which active learning is experienced intensively by creating inspiration for the richness of nature, technological innovations, activities and products for education and training processes will be more successful.

### STEM and Nature Education

Natural habitats are the fastest learning environments (Özdemir, Akfırat & Adıgüzel, 2009). Informal environments are important in complementing the knowledge and skills learned in schools, allowing research and experimentation, and enabling children to think in a questioning and versatile way to reach knowledge (Noel-Storr, 2004). Nature is an unlimited learning environment for children. Using the outdoors as a classroom increases children's natural curiosity and enthusiasm. Providing education outside meets students' kinesthetic needs, a 15-minute neighborhood walk or play break on natural surfaces can calm restless minds and increase children's ability to concentrate and creativity (Cleaver, 2007). Children need nature to develop their senses healthily and therefore to learn and enhance their creativity (Louv, 2019).

Researchers point out that environmental education in the natural environment enables students to explore real-life examples of principles, problems, and issues (Ballantyne, Fien & Packer, 2001). Courses in nature encourage children to collaborate, be more creative, and solve problems (Buldur, Bursal, Yücel & Yalçın Erik, 2018). Nevertheless, due to the crowded city life, distance from natural living, living conditions and the fact that technology also surrounds children's world, children spend less time in nature. Experts state that children with less time in nature have dulled physical and mental senses and poor experiences (Louv, 2019).

According to leading landscape architect Frederick Law Olmstead (1865), it has long been accepted that natural scenery works the mind without causing fatigue, calms and revitalizes the body, and has a refreshing relaxation and revitalization effect on the entire system (Kimbell, Schuhmann, & Brown, 2009). Today's children live away from the environments that provide mental tranquility. However, nature deprivation is one side of the coin, and the other side is the abundance of nature. Indeed, new research focuses on what is gained by nature's presence rather than what is lost in its absence (Louv, 2019).

Today, nature-based learning environments are overshadowed by indoor digital high-tech environments. The effect of digital tools on learning is undeniable when used appropriately. Therefore, it is thought that an effective learning design can be created by combining the strengths of these two environments. In this study, an effective learning design was attempted to be created by using the strengths of both environments. Yıldırım and Altun (2015) state that STEM is an approach that processes knowledge found in nature. Therefore, the STEM education approach is based on the designed education. The STEM approach is used in the designed education to understand how science, technology, engineering, and mathematics are applied in natural environments and to solve problems related to these fields.

As Tuğluk and Öcal (2017) suggest, if it is wanted to meet technical and technological innovations that will most likely lead to future economic and social developments, more researches on STEM fields are needed. This study aims to fill this gap in Turkey. Therefore, the participants are planned to connect the natural sciences to the technology after the activities that were described as nature based learning. For this purpose, the following questions were sought to be answered in the study.

1. What are the students' opinions (regarding preparation, use of materials, course process and contribution) about Nature-Based Learning Activities (Drama, Biomimicry, Ecoprint, Basic Electricity, Metamorphosis and Build Bridges with Science).
2. What are the students' opinions (regarding preparation, use of materials, course process and contribution) about "Digital Storytelling, Algorithm, Augmented Reality and Visual Block Programming" which are the activities of Technology-Integrated Learning?

In the first category “Drama, Biomimicry, Ecoprint, Basic Electricity, Metamorphosis and Build Bridges with Science” courses are selected as nature courses because of emerging from nature itself. In second category the courses “Digital Storytelling, Algorithm, Augmented Reality and Visual Block Programming” are taken as technology integrated courses because these courses base technology itself. In each category, the components of curriculum, goals, content, process and evaluation (Demirel, 2006) gave inspiration to name the activities as preparation, use of materials, course process and contribution.

## METHOD

### Research Design

The study is qualitative research conducted using a case study model. Qualitative research aims to obtain in-depth data by questioning the causes and reasons per the research objective. According to Creswell (2007), a case study is a qualitative research approach where the researcher deeply examines one or more limited situations over time using multiple data collection tools (observations, interviews, audio-visuals, documents, reports) and identifies themes related to the situations and conditions.

### Participants

In this study, the opinions of 37 secondary school students regarding the courses carried out in the summer term of the 2020-2021 academic year were collected using a semi-structured interview form as one of the qualitative data collection tools. For the selection of the participants, leaflet including a brief description of the activities, were posted to the schools. After the consultancy with the family of the students, the directory decided the participants and sent 40 students’ name to the project coordinator/author. The study group of the research was determined by the criterion sampling method, one of the purposeful sampling methods. According to Patton (1987), all situations that meet a set of predetermined criteria are studied in criterion sampling. The researcher can prepare the criterion or criteria, or a list of previously established criteria can be used. In this study, the students who met the predetermined criteria such as being at the secondary school level, having an interest in nature, being willing to participate in activities outside the school period, and having permission from their families with a consent form were included in the study group.

### Research Instruments and Processes

The semi-structured interview form prepared by the researchers was used to evaluate the technology-integrated workshops conducted with the STEM approach in the context of nature courses from the students' point of view. The form was designed to collect student opinions under the headings of Preparation, Material, Course Process, and Contribution, which are the main dimensions of the education and training program, in line with experts' opinions after a relevant literature review. To ensure the validity and reliability of the form, opinions were obtained from three experts. Two experts are faculty members in education programs and teaching, while the third expert is a faculty member working in Instructional Technologies. Necessary corrections were made after obtaining expert opinions, and expression errors were corrected to finalize the form. Obtaining opinions from people who have general knowledge about the research topic and specialize in qualitative research methods is another precaution that can be taken regarding credibility. The expert helps the researcher increase the quality of the research by providing feedback at various stages of the study, from the research design to the collection and analysis of data and writing of the results (Şimşek & Yıldırım, 2018).

When designing the courses, the interdisciplinary STEM approach was adopted, which supports 21st-century skills and provides a rich environment for developing these skills (Kavak, 2020). The courses are divided into two groups: nature-based and technology-integrated. Nature courses were carried out by experts specialized in different fields, who are familiar with the STEM education approach, in natural environments and outdoors. technology-integrated courses were conducted by experts specialized in their fields in a laboratory environment and who are also familiar with the STEM education approach. During the courses, each nature course was connected to an technology-integrated course, and concrete examples were given of how nature inspires technology. The studies focused on integrating STEM concepts and practices, and the disciplines were interrelated to create a holistic learning environment.

All the courses were designed for the interdisciplinary approach underlying STEM. For example, in the Ecoprint workshop, students learned how to obtain colors with the materials they collected from nature, calculated the ratio in which they needed to mix these colors, got to know the natural chemical components used in obtaining colors, experienced which fabric absorbs how much colors, and analyzed the right techniques and weather conditions to obtain the colors they wanted in the drying process. All courses were carried out in this direction by adopting the interdisciplinary approach required by the STEM discipline. After learning how to obtain colors in the nature activity, they learned how colors are created in the digital environment, saw how digital colors are created with special software on the graphical screen, wrote their programs by performing the necessary mathematical operations and designing their algorithms, designed an experimental setup where they could see the program they wrote concretely, and developed projects that produce different colors according to the data from different sensors. For example, one of our students stated that he was inspired by the chameleon in his project and designed a project that changes color according to light and heat. In the meantime, he discovered that sensors such as heat and light, which are used in digital projects, exist naturally in animals. Since environments such as summer camps provide students with flexible and collaborative contexts and engage them in more hands-on and cognitive activities (Ayar, 2015), the course activities were carried out for 70 hours over ten days during the summer.

The descriptive analysis method was used to analyze student opinions. Based on the data obtained from students' opinions about the Preparation, Material, Course Process and Contribution dimensions of both technology-integrated and Nature-based Activities, codes were created and presented numerically in the tables. The repetitions frequency was determined and frequencies were included in the table. Another researcher also analyzed the sentences and the evaluation from filled out, and the reliability formula suggested by Miles and Huberman (1994) was used for the reliability calculation of the study. Reliability = Agreement / (Agreement + Disagreement). As a result of the calculation (1814/1814+45), the reliability of the study was calculated as 97% which indicates the process of coding and analysis are reliable.

To ensure that the study results are transferable, the data obtained were tried to be transferred by organizing them according to concepts and themes without disturbing their natural state or adding comments. The participants' statements about the themes and concepts that emerged in the findings section are given by direct quotation to achieve this. The frequency numbers of the findings obtained are given in the tables.

Participants were given some codes such as Ö1,Ö2,Ö3, etc. to follow their replies for different activities. Opinions structured under two different themes, namely "nature-based" and "technology-integrated", were analyzed in the preparation category, and the findings collected under three sub-categories named "course duration", "environment" and "preparedness for the lesson". For example, one of the students, [Ö5], "Duration of the activity is adequate and the environment is nice". The coding was constructed as;

Name of student= Student5

Theme= Nature based course

Sub-theme= Ecoprint

Category= Preparedness

Sub categories: Duration and environment

Codes= Sufficient and suitable

**Ethic**

The necessary ethics committee permissions for the research were obtained from the Social Sciences Ethics Committee of Kırşehir Ahi Evran University with the decision dated 03.12.2019 and numbered 35/04.

## FINDINGS / RESULTS

The preparations, materials, lesson process, and contributions to students regarding the courses carried out within the scope of STEM-based education for students have been analyzed, and the codes and concepts obtained have been divided into two different course groups under the titles of Nature and technology-integrated courses.

### Preparations for the Courses

Depending on the categorical content analysis, opinions structured under two different themes, namely "nature-based" and "technology-integrated", in a category (preparation), and the findings collected under three sub-categories named "course duration", "classroom environment", and "preparedness for the lesson" are presented in Figure 1.

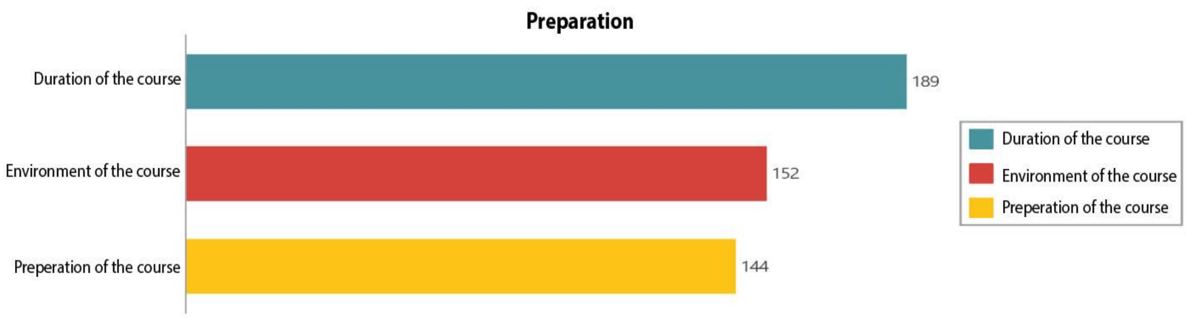


**Figure 1.** *Students' views on the preparation category*

Upon examining Figure 1, it can be observed that the opinions of the students (n=189) regarding the duration of the lesson in the context of the courses they participated in are more prominent than their opinions on the classroom environment (n=152) and come ready prepared to the lesson (n=144). The hierarchical code-subcode model was used to analyze these opinions based on which course they belong to, and the results were presented in the form of figures and tables.

***Course Duration***

Students' views on the duration of courses in the preparation phase were categorized under two different themes, nature-based and technology-integrated, and codes, "sufficient", "insufficient", and "excessive" were given with the distribution of frequencies to the courses is presented in Table 1.

**Table 1.** *Students' views on the duration of the course*

| | **Nature-based courses** | | | | | | ***Technology-integrated course*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Course Duration | Drama | Biomimicry | Ecoprint | Basic Electricity | Metamorphose | Build bridge with science. | *Digital Storytelling* | *Algorithm* | *Augmented reality /Visual Blk* | ∑ |
| Sufficient | 9 | 9 | 16 | 14 | 14 | 12 | *19* | *8* | *13* | 114 |
| Insufficient | 8 | 12 | 5 | - | 6 | 9 | *3* | *2* | *5* | 50 |
| More than necessary | 3 | - | 1 | 1 | 3 | - | *3* | *11* | *3* | 25 |
| Total | 20 | 21 | 22 | 15 | 23 | 21 | *25* | *21* | *21* | 189 |

Upon examining Table 1, it can be seen that for both Nature-based and Technology integrated courses, except for the "biomimicry course," the frequency of opinions indicating that the duration of the courses during the preparation is "sufficient" is greater than those stating it is "insufficient" or "more than necessary." In the case of the "biomimicry course," there are 12 opinions stating that the duration is "insufficient" while 9 opinions consider it "sufficient." Additionally, the number of opinions claiming that the duration of the "Algorithm course" is "more than necessary" (n=11) is greater than those of other courses. While there are 40 opinions indicating that the time allocated for Nature-based courses is "insufficient," there are 17 opinions stating that the duration of İnformatics-based courses is "insufficient." Therefore, it can be said that more time should be allocated to Nature-based courses based on the 40 opinions claiming that the duration is "insufficient." The visualization of the opinions regarding the duration of courses is presented in Figure 2.

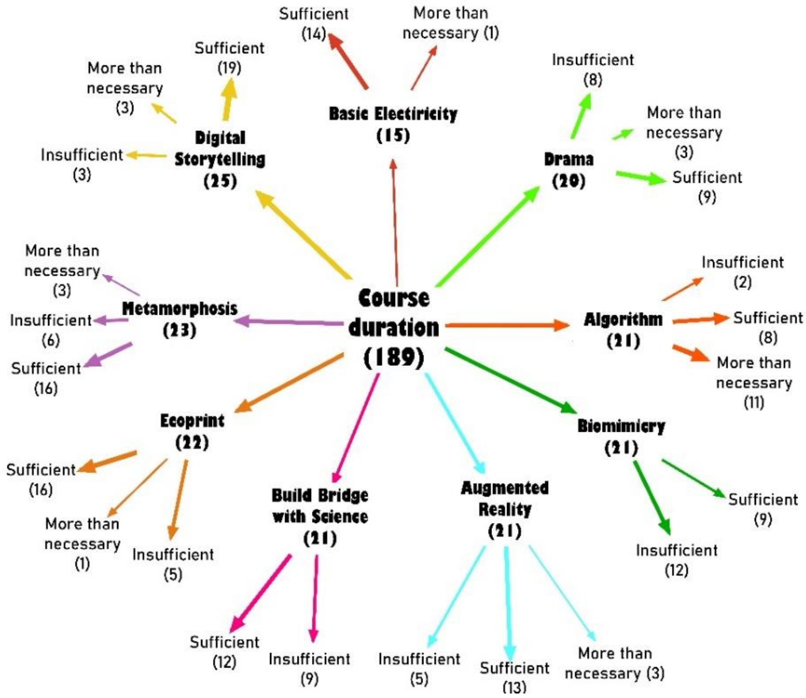


**Figure 2.** *Students' Views on the Duration of the Activities*

When examining the duration of the nine courses in Figure 2, it is understood that a total of 189 opinions on Nature-Based (n=122) and İnformatics-Based (n=67) courses were expressed. In addition, it is observed that the opinions regarding the "Digital Storytelling" course (n=25) are the highest and those related to the "Basic Electricity" course (n=15) are the least.

Sample quotations:

[Ö5]: "Duration of the activity (Drama) is adequate and the environment is nice".

[Ö12]: "The teacher has already done the preparations, duration of the activity (Biomimicry) could be longer and the environment is nice".

***Course Environment***

It was observed that the students' opinions regarding the course environment during the preparation were grouped under two different themes, namely nature-based and informatics-based, and the codes, namely "suitable" or "not suitable" were given with the distribution of the frequencies for these categories according to the courses is presented in Table 2.

**Table 2.** *Students' views on the course environment*

| | Nature-based Courses | | | | | | *Technology-integrated Courses* | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Course Environment** | Drama | Biomimicry | Ecoprint | Basic Electricity | Metamorphosis | Build a bridge with science | *Digital Storytelling* | *Algorithm* | *Augmented Reality /Visual Blk.* | ∑ |
| Suitable | 20 | 14 | 23 | 10 | 16 | 11 | *17* | *8* | *11* | **130** |
| Not suitable | - | 1 | - | 4 | 1 | 4 | *1* | *7* | *4* | **22** |
| Total | 20 | 15 | 23 | 14 | 17 | 15 | *18* | *15* | *15* | **152** |

Upon examining Table 2, it is understood that the number of views stating that the environment of nature-based and technology-integrated courses is suitable is considerably higher than those claiming it is unsuitable. While there are 94 views stating that the environment of nature-based courses is suitable only 10 claim it is unsuitable. Similarly, for technology-integrated courses, there are 36 views stating that the environment is suitable, while only 12 views are claiming it is unsuitable.

Additionally, it is noteworthy that the views claiming that the environment of the Algorithm Course is unsuitable are close in number to those stating it is suitable. The visuals for all the course's views on the course location are presented in Figure 3.

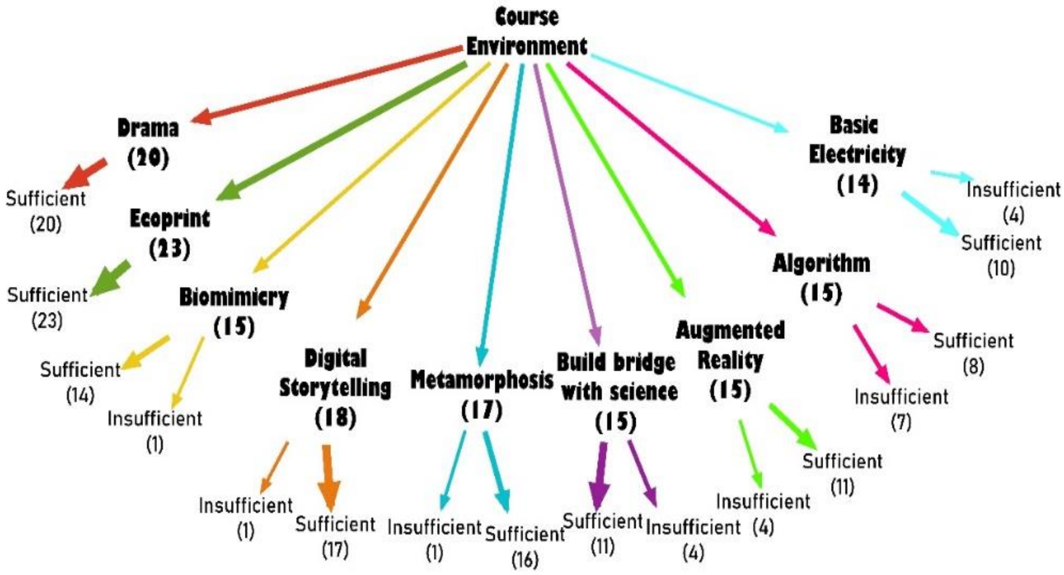


**Figure 3.** *Students Views on the Course Environment*

Upon examination of the environment of the courses presented in Figure 3, it is understood that there are 152 opinions regarding Nature-Based courses (n=104) and Informatics-Based courses (n=48). In addition, it is observed that the "Ecoprint" course has the highest number of opinions (n=23), while the "Basic Electricity" course has the lowest number of opinions (n=14). Furthermore, given that 130 out of 152 opinions express positive statements about the course environment, it can be inferred that the course arrangements are sufficient.

Sample quotations:

[Ö30]: “The duration of the lesson (Basic Electricity) is good, the place is nice, I’ve had a lot of fun.”

[Ö18]: “The lesson is nice (Algoritm) but, there is not enough fresh air in the classroom.”

***Preliminary Preparation of Instructors***

Upon examination of the data, it is observed that the students’ opinions regarding the instructors’ preparedness for the courses were categorized under two themes, namely nature-based and technology-integrated, and two codes, “prepared” and “not prepared” were presented with the distribution of frequencies for these categories according to the courses is presented in Table 3.

**Table 3.** *Students' opinions on the preparedness of the instructors to participate in the courses*

| | **Nature-based Courses** | | | | | | ***Technology-integrated courses*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Preliminary Preparation of Instructors** | Drama | Biomimicry | Ecoprint | Basic Electricity | Metamorphosis | Build a bridge with science | *Digital Storytelling* | *Algorithm* | *Augmented reality /Visual Blk* | Σ |
| Prepared | 11 | 13 | 21 | 16 | 15 | 13 | *16* | *17* | *15* | **137** |
| Not prepared | - | - | - | - | 2 | 2 | *1* | *2* | - | **7** |
| Total | 20 | 15 | 23 | 14 | 17 | 15 | *17* | *19* | *15* | **144** |

According to Table 3, it is observed that for both nature-based and technology-integrated courses, the views on the preparedness of instructors are categorized as "prepared". Moreover, the term "not prepared" regarding instructors' preparedness is not mentioned, particularly for the Drama, Biomimicry, Ecoprint, Basic Electricity, and Augmented Reality courses.

According to Table 3, while there were 89 opinions indicating that the teaching staff were adequately prepared for the Nature-based courses, only 4 suggested inadequacy. Similarly, for the İnformatics-based courses, out of 48 opinions indicating adequate preparation by the instructors, only 3 opinions suggested "not prepared". All opinions regarding the preparedness of the teaching staff are presented visually in Figure 4.

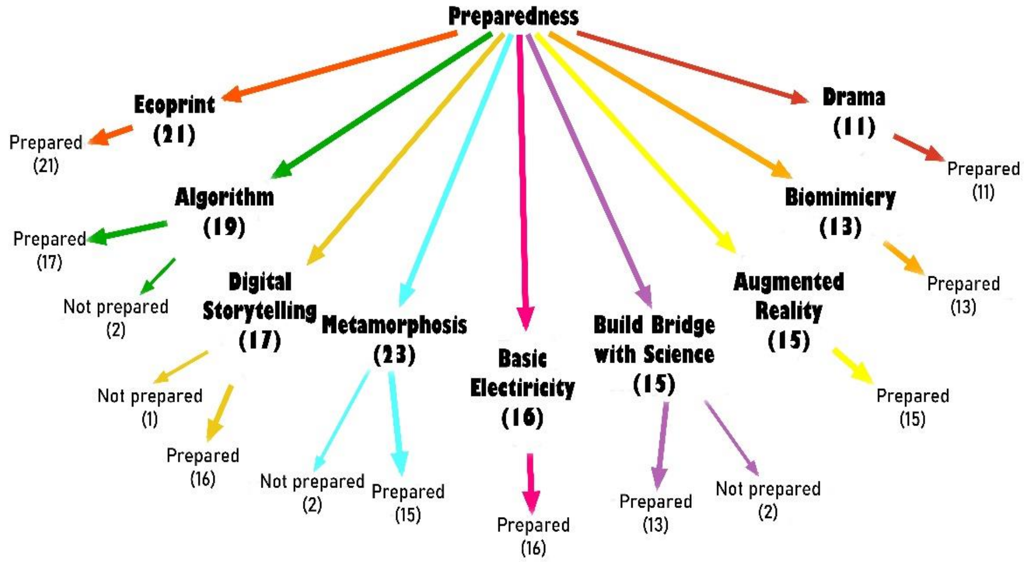


**Figure 4.** *Student Views on the Preparedness of Instructors*

When the preparedness of instructors who conducted the courses presented in Figure 4 is examined on a course basis, it is understood that there are 144 opinions regarding nature-based courses (n=93) and technology-integrated courses (n=51). In addition, it is observed that the opinions on the "Ecoprint" course (n=21) are the highest, while the opinions on the "Drama" course are the lowest (n=11).

Sample quotations:

[Ö26]: "Preparations for the activity (Digital Story Telling) is adequate but the course is little boring and the environment isn't nice, it is hot."

[Ö11]: "She comes to the classroom (Ecoprint) very prepared; she takes care of everything, the lesson has held in the garden, it is suitable for this event."

**Material**

Students' opinions regarding the teaching materials were classified under two different themes, nature-based and technology integrated, and seven codes (enough, interesting, not enough, not interesting, easy to use, difficult to use, not used) were given with the distribution of the frequencies of these categories for each activity is presented in Table 4.

**Table 4.** *Students' views on the course material*

| | Nature-based Courses | *Technology-integrated Courses* |
|---|---|---|

| **Material** | Drama | Biomimicry | Ecoprint | Basic Electricity | Metamorphosis | Build a bridge with science | *Digital Storytelling* | *Algorithm* | *Augmented Reality /Visual Blk.* | ∑ |
|---|---|---|---|---|---|---|---|---|---|---|
| Enough | 19 | 18 | 16 | 20 | 15 | 19 | *23* | *20* | *16* | **166** |
| Interesting | 9 | 28 | 28 | 27 | 24 | 21 | *14* | *17* | *24* | **192** |
| Not enough | - | 2 | 1 | 1 | 4 | 5 | *1* | *3* | - | **17** |
| Not interesting | 5 | - | 1 | 4 | 4 | 4 | *4* | *12* | *5* | **39** |
| Easy to use | 8 | 14 | 19 | 18 | 18 | 16 | *16* | *17* | *12* | **138** |
| Difficult to use | - | 7 | - | 3 | - | 1 | *1* | - | *3* | **15** |
| Not used | 14 | 1 | - | - | - | - | *3* | *2* | *1* | **21** |
| Total | 55 | 70 | 65 | 73 | 65 | 66 | *62* | *71* | *61* | **588** |

According to Table 4, it is observed that the positive aspects of the learning materials used in nature-based and technology-integrated courses, such as being interesting (n=192), "enough" (n=166), and "easy to use" (n=138), stand out. However, it is also understood that there are negative aspects expressed such as" not enough" (n=17), "uninteresting" (n=39), and difficulty to use (n=15) regarding the materials used in these courses. Additionally, it should be noted that materials weren't used in 5 courses (n=21). All the opinions regarding the quality of the materials used in the courses are presented in Figure 5.

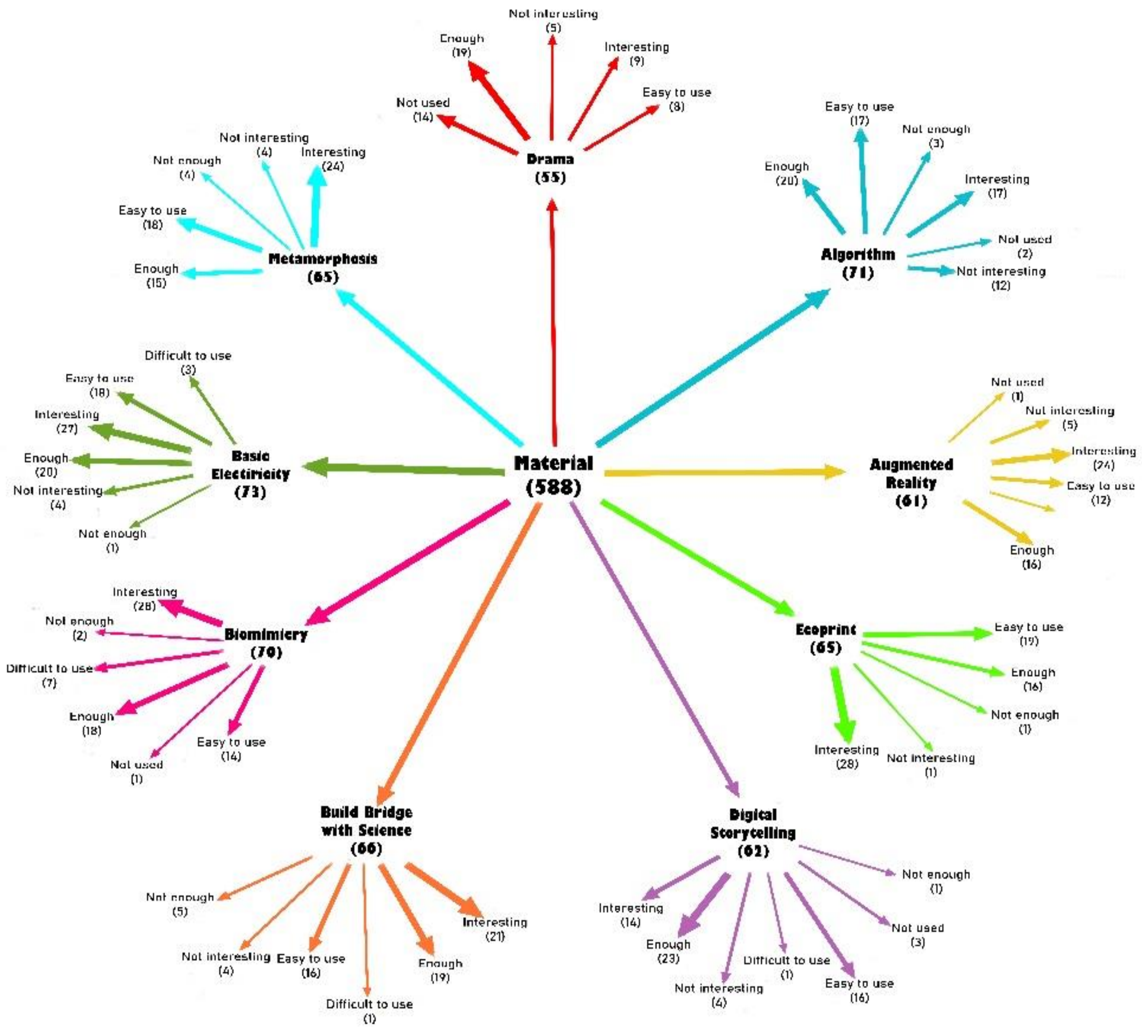


**Figure 5.** *Student Views on the Materials Used in the Courses*

When the opinions regarding the materials used in nine courses in Figure 5 are examined, it is understood that there are 588 opinions for nature-based courses (n=394) and technology-integrated courses (n=194). Moreover, it is observed that there is the highest number of opinions about the materials used in the "Basic Electricity" course (n=73), while the lowest number of opinions is about the materials used in the "Drama" course (n=55).

Sample quotations:

[Ö15]: “Materials of the activity (Drama) are very interesting and sufficient.”

[Ö20]: “The materials are interesting, easy to use and sufficient (Augmented Reality).”

**Process**

It has been observed that students' opinions regarding the activity process are grouped under two different themes, nature-based and technology-integrated, and four different codes, namely "student-centered", "interesting", "suitable methods/techniques used", or "boring" were given with the frequency distributions of these categories by activity are presented in Table 5.

**Table 5.** *Students' views on the activity process*

| | **Nature-based courses** | | | | | | ***Technology-integrated Courses*** | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Process** | Drama | Biomimicry | Ecoprint | Basic Electricity | Metamorphosis | The science builds a bridge | *Digital Storytelling* | *Algorithm* | *Augmented Reality /Visual Blk.* | ∑ |
| Student-centered | 17 | 11 | 10 | 11 | 8 | 10 | *13* | *8* | *13* | **101** |
| Interesting | 23 | 18 | 22 | 18 | 17 | 15 | *14* | *10* | *16* | **153** |
| Suitable Method | 8 | 18 | 19 | 14 | 10 | 17 | *15* | *13* | *17* | **131** |
| Boring | 1 | - | - | 4 | 6 | 1 | *3* | *12* | *2* | **29** |
| Total | 49 | 47 | 51 | 47 | 41 | 43 | *45* | *43* | *48* | **414** |

According to Table 5, students' opinions on the nature-based and technology-integrated activity process are predominantly expressed in positive terms, with the categories of student-centered, interesting, and suitable methods used (n=385); however, there are also a small number of students who find the process boring (n=29). The visual representation of all opinions on the activity process can be found in Figure 6.

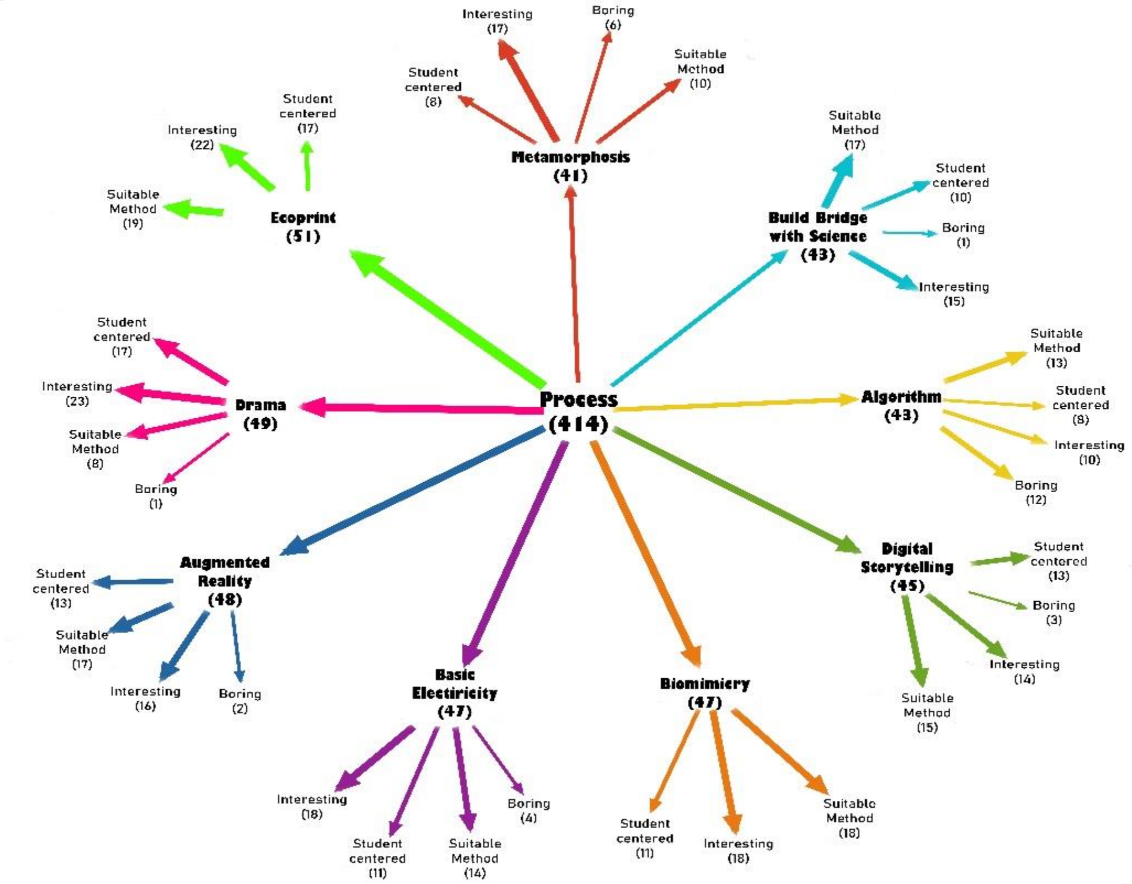


**Figure 6.** *Student Views on the Activity Process*

When the opinions on the activity process of nine courses presented in Figure 6 are examined, it is understood that a total of 414 opinions were expressed in the context of nature-based courses (n=278) and technology-integrated courses (n=136). In addition, it is observed that the opinions on the activity process in the "Ecoprint" course (n=51) are the most, while the opinions on the activity process in the "Metamorphosis" course (n=41) are the least.

Sample quotations:

[Ö20]: “In the course (Augmented Reality), teacher’s instructing method is attractive, I’ve participated the activities.”

[Ö3]: “The activity (Building Bridge) is enjoyable, we perform team work.’

**Contribution**

The students’ views regarding the courses’ contribution were grouped under two different themes nature-based and technology-integrated, and eight different codes (academic development, contribute the science, social development, environmental awareness, self-confidence, disciplinary knowledge, information tools, no contribution) with the distribution of the frequencies of these categories according to the courses is presented in Table 6.

**Table 6.** *Students' views on the contribution of the courses*

| | Nature-based courses | *Technology-integrated Courses* |
|---|---|---|

| **Contribution** | Drama | Biomimicry | Ecoprint | Basic Electricity | Metamorphosis | Build a bridge with science | *Digital Storytelling* | *Algorithm* | *Augmented Reality /Visual Blk.* | ∑ |
|---|---|---|---|---|---|---|---|---|---|---|
| Academic Development | - | 4 | 3 | 5 | 2 | 3 | *9* | *4* | *5* | **35** |
| Contribute to Science | 2 | 4 | 4 | 5 | 5 | 4 | *3* | *3* | *4* | **34** |
| Social Development | 21 | 8 | 7 | 2 | 5 | 8 | *4* | *6* | *5* | **66** |
| Environmental Awareness | 5 | 2 | 19 | 2 | 6 | 2 | *3* | *1* | - | **40** |
| Self-confidence | 2 | 1 | - | - | - | 1 | - | - | - | **4** |
| Disciplinary knowledge | 3 | 5 | 11 | 12 | 12 | 17 | *10* | *8* | *15* | **93** |
| Information Tools | - | 13 | - | 6 | 2 | - | *8* | *7* | *6* | **42** |
| *No Contribution* | - | *1* | - | *4* | - | - | *2* | *5* | *1* | ***13*** |
| Total | 33 | 38 | 44 | 36 | 32 | 35 | *39* | *34* | *36* | **327** |

Upon examination of Table 6, it can be seen that 314 views on the contribution of nature-based and technology-integrated courses expressed" individual, social, and disciplinary contributions". At the same time, only 13 states "did not contribute". Notably, the courses' contribution to self-confidence (n=4) is low. Another point that attracts attention is that the views expressing contribution to disciplinary knowledge (n=93) are numerically high. The views on the duration of the courses are presented in Figure 7.

Sample quotations:

[Ö9]: "Normally I think I'm bad at architecture, but this course changed my mind on that subject."

[Ö30]: "It contributes to socialization, it is good in terms of contribution to science, I've had a lot of fun, and it helps to look from the perspective of nature and information tools (Ecoprint)."

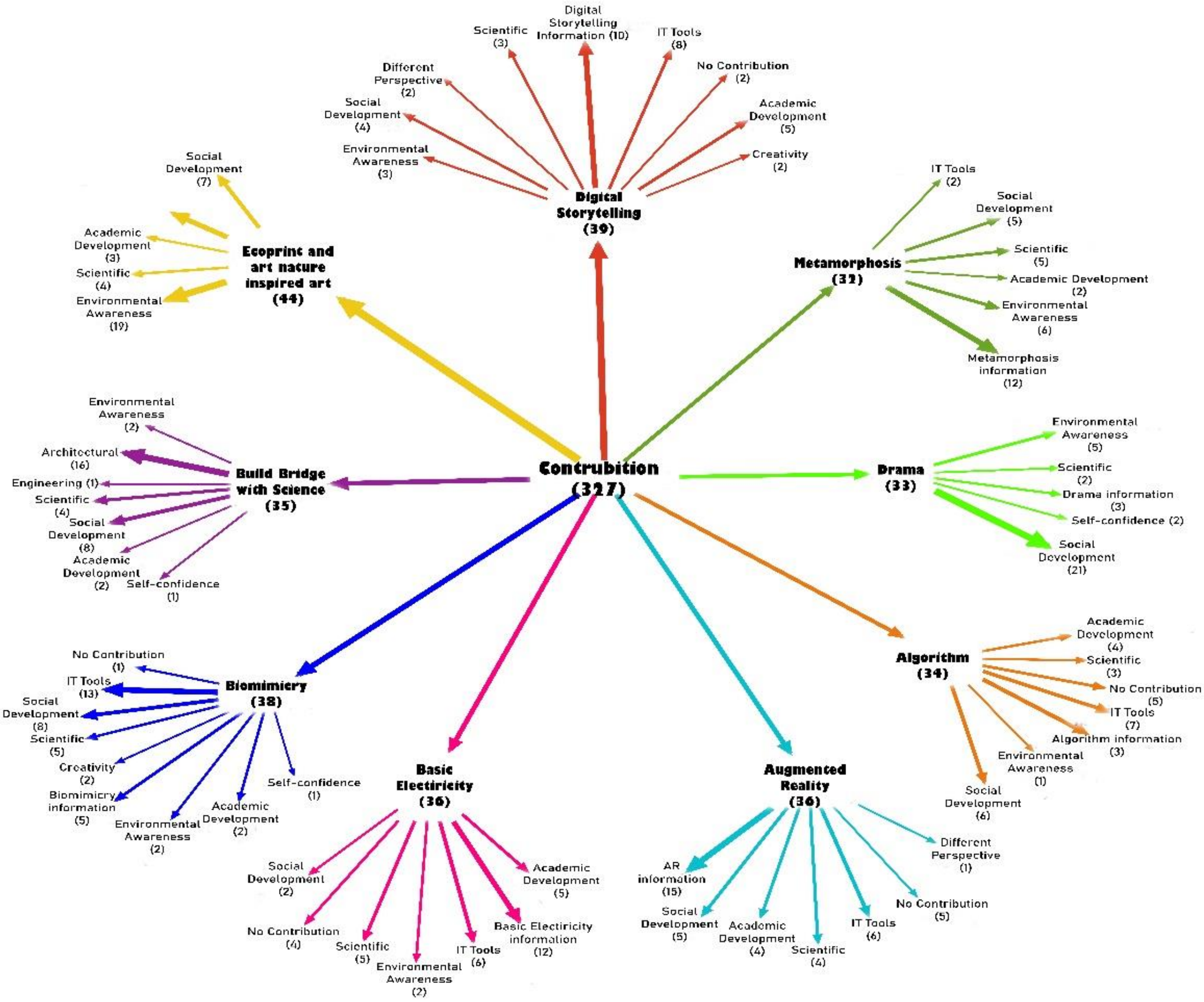


**Figure 7.** *Student Views on Contribution of the Courses*

When the student views on the contribution of the courses in the 9 courses presented in Figure 7 were examined, it was understood that there were 327 views on nature-based courses (n=218) and science-based courses (n=109). In addition, while there were views that the "Ecoprint" course contributed the most (n=44), the views on the "Metamorphosis" course were the least (n=32).

**DISCUSSION, CONCLUSION, RECOMMENDATIONS**

When the research results are examined, the students found the duration of the courses sufficient in both nature-based and technology-integrated courses. Still, the predominant view was that there should be more time, especially in nature-based courses. Although more time is allocated to nature-based courses due to their nature, students have expressed a desire to spend more time in these courses. This demonstrates that children living in today's digital age are willing to spend time in a carefully planned and effective natural learning environment. In the technology-integrated courses, there was a predominant view that the duration of the biomimicry course was too short. In this course, the information about how the natural environment inspires technology was explained with examples, and its connection to real life was demonstrated concretely throughout the course. In addition, students were asked to design an effective airplane and wing using a 3D pen. The 3D pen they used attracted their attention and they wanted to spend more time with this tool. Therefore, it is thought that the course duration may have been perceived as too short for them. Furthermore, most students in the algorithm course stated that the duration was longer than necessary. According to the literature, even at the university level, computer programming and the fundamental skill of algorithm creation are considered difficult skills (Özmen and Altun, 2014). Algorithms are inherently abstract skills, which makes them difficult to understand. Indeed, in Gökoğlu's (2017) metaphor analysis of algorithm perception, it was found that students had a negative view of algorithms. It is expected that the duration of learning a difficult concept is perceived as long for students.

In the study, the environment suits nature-based courses while only 10 opinions of 94 suggest the opposite. For technology-integrated courses, 36 consider the environment suitable, while 12 suggest it is not. Of 152 opinions, 130 conclude that the learning environment is sufficient for the courses. Similarly Bybee (2013) concluded that the selected environments for both types of courses are adequate to meet the needs of students and the curriculum. Additionally, it is noteworthy that the opinions regarding the suitability of the Algorithm Course's environment are closer to those who consider it suitable. Therefore, it is believed that collaboration with stakeholders is necessary to create environments that require specific arrangements for the field.

A study found that the instructors who conducted the courses in 9 courses within the scope of the study were prepared for the courses, and only 7 of the total 144 views related to nature-based courses (n=93) and technology-integrated courses (n=51) contained negative comments. Additionally, it was found that the instructor of the "Ecoprint" course was the most prepared (n=21), while the responsible teacher of the "drama" course was the least prepared (n=11). This may be because drama lessons are open to changes before and during the lesson and can be subject to instant changes. In summary, it is seen that the opinions on the preparedness of the teaching staff for the lesson are largely "sufficient". Guven's (2004) study emphasized that effective teachers have knowledge about objectives, attach importance to time management, enter the lesson on time, leave on time, and continue teaching without panicking or hesitating with good planning and preparation. Sönmez (2017) named education as teaching in schools. Teaching is making necessary preparations for a lesson according to the teaching program, carrying out the process, and continuing the process until the goals are reached (Özçelik, 2014). Teaching is a difficult process that requires long working hours, preparation and planning skills (Moore, 2001). According to the results of the current study, it was concluded that the teaching staff successfully carried out these processes and supported student motivation with effective preparations.

At the same time, it was observed that the positive characteristics of the materials used in nature-based and technology-integrated courses, which were expressed as interesting, enough, and easy to use, were prominent. However, it was also understood that the teaching materials have negative aspects, such as being “not enough, uninteresting, and difficult to use”. Although this is thought to be because most students encounter the material for the first time and do not have any experience with it, it is a topic that needs to be investigated. Günbatar & Tabar (2019) stated that since STEM is an integrated approach, studies where researchers, teachers, and participants from different fields come together, would be more suitable for the STEM philosophy. In this study, since different education and research courses from the fields of information and basic sciences were included, it is considered that a learning environment suitable for the STEM philosophy was created. Indeed, the views of the students on the activity process, expressed as student-centered, interesting, and appropriate methods, and the predominance of positive views support this idea. Regarding the students' views on the contribution of nature-based and technology-integrated courses to themselves, they mentioned their domain-specific knowledge, social development, environmental awareness, use of information tools, and problem-solving skills. Therefore, it can be said that these courses contribute to the holistic development of the students.

The results are similar to the study conducted by Gencer, Doğan, Bilen, & Bilge (2019), which shows that the integration of STEM concepts and practices, which constitute the focus of the current study, supports the gains in the field of engineering and technology, as well as providing promising information that the integration of STEM concepts and practices leads to increased conceptual learning within disciplines.

It is important for students to see where they can use the knowledge they have learned in daily life and to realize the relationship between disciplines at an early age (Dilber, Tertemiz & Taşdemir, 2020). In this study, unlike previous STEM studies in the literature, it is thought that supporting nature and technology-integrated courses with each other and including applications that have not been done before on a course basis, enables students to see where they can use their knowledge in daily life and to realize the relationship between disciplines. Still, it is recommended to be investigated by applying it to a larger sample.

The limitations of this study include the fact that the data is specific to a particular geographical region, the limited size of the research sample, and the short duration of the implementation. Therefore, the generalizability of the obtained results to a broader population may be limited.

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