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Reshaping technology-based projects and their exploration of creativity

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Abstract
This study explores how reshaping technology-based projects in learning designed using SAMR framework (substitution, augmentation, modification, redefinition) can influence students' creativity. This research is a mixed method, combining quantitative data and qualitative data. The researcher analyzed the results of the students' pretest and posttest scores and questionnaires and coded the interviews' results. The research participants were 175 Indonesian students who took a hybrid learning class. This study uses the results of structural equation modeling to determine the contribution of technology to student creativity. The results showed that the most explored creativity indicator was flexibility and the least explored was elaboration. Based on the level of technology use in the SAMR framework, the modification level has the most influence on students' creativity, while the substitution level has the least influence. Technology tends to be used as a substitute for traditional learning. Our research shows that the level of technology use in SAMR influences the level of creativity in students' projects with varying impacts. This study concludes that integrating technology into learning in stages contributes to exploring students' creativity and automatically increases their mastery of technology.

Keywords: creativity, project, SAMR

INTRODUCTION

Due to limited access to information and academic facilities, student project assignments tend to be lacking and only meet standards (Lou et al., 2017; Mihardi et al., 2013). To improve the quality of teaching and learning, it is believed that the integration of technology into learning combined with a constructivist pedagogic approach has a significant impact on student project outcomes (Alzahrani & Emsley, 2013; Bray & Tangney, 2017; Stein et al., 2013). In conventional classrooms, lecturers are a dominant source of knowledge. Therefore, a pedagogical approach that integrates technology is unsuitable for this teaching culture. Lecturers must master strategies for integrating technology and pedagogy that allow students to explore their cognitive skills, including problem-solving, decision-making, innovation, creativity, planning, and organizing (Dwiyogo, 2018; Taylor et al., 2020).

Students can improve the quality of their project assignments using their devices, such as laptops, phones, tablets, and iPads. Furthermore, multimedia can be a solution for students who have low achievement and need more guidance from the teacher (Jufriadi et al., 2019; Tseng, 2019). However, in practice, using technology without a clear pedagogical concept can confuse students and does not fully provide them with a positive learning experience (Bray & Tangney, 2017; Jude et al., 2014; Martín-Gutiérrez et al., 2017). Technology integration can be successfully implemented in schools if schools and teachers have clear pedagogical goals formulated in the learning model (Genlott et al., 2021; Koehler et al., 2013). Integrating technology in learning, especially in project-based tasks, requires reshaping to optimally achieve the desired learning outcomes. Reshaping is also needed to minimize the obstacles encountered in using technology in learning.

SAMR framework (substitution, augmentation, modification, redefinition) focuses on integrating technology into pedagogy to improve the quality of the teaching and learning process (Ahmed & Chao, 2018; Boelens et al., 2017). SAMR is a framework that describes

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Contribution to the literature

- This study has contributed to the existing literature on how to integrate technology in the classroom so that it can have an impact on student creativity.
- This study has shown how the correlation of each level of the SAMR framework can have implications for each component of creativity.
- The result of the study has shown how important teachers' ability to choose and use technology has affected students' cognitive abilities, especially on their creativity skills.

how an educator can develop a constructivist learning perspective by integrating technology into teaching and learning. Technology integration simplifies the process for stakeholders involved in learning (Glaveanu et al., 2020; Hilton, 2016; Martínez-Cerdá et al., 2020). SAMR Integration can be used when integrating technology into learning. (Puentedura, 2014) describes four levels of technology integration:

1. Substitution, where technology is used as a substitute for classroom equipment without a change in function.
2. Augmentation, where technology is used instead of equipment used with additional or improved functions.
3. Modification, where technology allows for a better change.
4. Redefinition, where technology makes it possible to create ways of working that were not possible before.

In other words, technology integration is proven to provide opportunities to find sources of knowledge that are not limited by space and time to make it easier for students to explore and maximize their creative thinking in working on projects (Azid & Md-Ali, 2020; Henriksen et al., 2016; Hoffmann et al., 2016).

Technology is widely integrated with pedagogy, although the relationship between technology and pedagogy is quite complex (Sothayapetch & Lavonen, 2022). In addition, technology integration can increase the desired learning outcomes. However, using technology in the classroom does not guarantee positive results. Technology integration requires clear concepts and objectives in working on projects. The SAMR framework is proven to increase the use of technology in learning and mastering Bloom's taxonomy (Netolicka & Simonova, 2017). However, research linking the SAMR framework, a form of technology integration in learning, with creativity is still scarce. There is an assumption that student creativity can be optimized through project assignments (Chien et al., 2020; Lou et al., 2017; Wu & Wu, 2020). Therefore, researchers need to reshape technology in learning by combining the SAMR framework and project-based learning to explore creativity and see how students' projects can enhance creativity.

This review is the basis of the purpose of this research to find out how reshaping learning that integrates technology in project-based learning can impact students' creativity in environmental physics learning. The use of technology is very appropriate for the environmental-themed learning process (Hernawan et al., 2022). Technology integration in learning is designed using SAMR framework in this study. Researchers use creativity indicators based on Torrance theory, where creativity is defined as an individual's ability to solve problems with various perspectives and based on fluency, flexibility, elaboration, and originality (Said-Metwaly et al., 2020; Trisnayanti et al., 2019). In detail, this study also looks at how the influence of reshaping impacts each indicator of creativity.

METHOD

The method used is mixed methods that combine qualitative and quantitative data to answer research questions more thoroughly (Creswell, 2014). Quantitative data were collected and analyzed to explore how reshaping technology integration in learning assists students in completing their projects through essay tests to determine their creativity. Qualitative data collection was carried out to complement the quantitative data. The qualitative approach was carried out through questionnaires and semi-structured interviews. Semi-structured interviews allow researchers to obtain information by referencing students' experiences (Chan, 2013; Cserháti & Szabó, 2014).

The subjects of this study were 175 students (98 women, 77 men) from three universities in East Java, Indonesia. Subjects are students who have taken environmental physics courses and are at least in the fourth semester. Students have mastered the basic concepts of physics and science in the previous semester at this stage. Thus, when students face environmental problems, they can provide solutions independently. The learning activities in this study were carried out with a hybrid learning approach, combining online and offline learning activities for seven weeks. COVID-19 pandemic has conditioned the courses to be conducted through hybrid learning so that students and lecturers can interact more closely without being limited by space and time (Yen, 2020). The hybrid learning approach encourages students to apply technology (Zhou & Yao, 2017). In this study, students must work in groups to complete projects to discuss and develop ideas in determining project topics. The form of the project given is open-ended, allowing students to answer and share experiences more freely (Welsh et al., 2013).

One of four subjects in the environmental physics course is designed to investigate students' creativity in undertaking technology-based projects. At the first meeting, students were given essential questions related to the project topic of soil characteristics and drought. To understand the problems in the project, students received a video link and some materials related to soil drought, the relationship between drought and soil characteristics, and the location of drought. Students are asked to make a video presentation that summarizes the phenomenon. In the second and third meetings, students link the concepts of waves, electricity, magnetism, and permeability with soil physical characteristics and collaboratively design projects to answer the phenomenon of drought from soil characteristics. At the fourth and fifth meetings, students conducted exploration using technology and interpreted the exploration results with the lecturer's help. This exploration and interpretation activity was carried out for four weeks so that there was more time to complete it. At the sixth and seventh meetings, the students presented and discussed the project results and reflected on their technology application activities. Students can also use the technology, software, and programs they want. Learning management system (LMS) used in learning is SPADA Indonesia and Google Classroom.

Students did a pretest to measure their creativity indicators (fluency, flexibility, elaboration, and originality) in the use of technology before the intervention was given. The pretest consists of five essay questions. After the intervention, an assessment through a posttest was given to students to see if students' creativity increased after working on technology-based projects. Each creativity test is conducted for two hours offline. Analysis using normalized gain (g) was conducted to process students' creativity pretest and posttest data. Interpretation is based on the value of g, categorized into low, moderate, and high criteria (Nissen et al., 2018).

Questionnaire data were obtained from 17 checklists of creativity indicators and 20 checklists of SAMR using a frequency scale of never, sometimes, rarely, often, and always. Lecturers directly observe how students' creativity is influenced by the technology students use. Observations were also made through LMS media, virtual meetings, and discussions using WhatsApp to learn students' creativity. Analysis of the questionnaire data was carried out by coding. The students were observed and interviewed about how they use technology and its impact on their creativity. Semi-structured interviews were conducted to explore students' experiences of using technology and how it helped them complete their projects, to find barriers faced by students, and to discover the involvement of individual roles in groups and the ease of using technology. Interviews were conducted once in groups, 30 to 60 minutes at the end of the research activity (Janthon et al., 2015). Interview data were analyzed by coding.

Analysis with coding was carried out based on data from interviews and observations of technology-based projects. The researchers coded the results of observations and interviews. The results of the interviews were transcribed and categorized into codes of technology students use. The coding allows the categorization of assignments and student responses to four SAMR codes. Furthermore, the interview transcript results were analyzed using theme analysis based on the emergence of themes related to students' experiences using technology, their perceptions of the advantages and disadvantages of technology, the challenges they face, and the role of group members in collaboration.

Coding analysis uses four codes based on SAMR that classify the level of technology used in teaching. SAMR consists of substitutions (SUB), augmentation (AUG), modification (MOD), and redefinition (RED) (Hamilton et al., 2016). Researchers apply the code according to the technology used. For example, we coded the use of software such as IP2Win, Origin 8, Res2DIV, and Progress3 as the technology used to complete the project (redefinition in SAMR). These data are then functionally categorized in the SAMR. As for the creativity observed, the codes used are fluency (FLU), flexibility (FLE), originality (ORI), and elaboration (ELA). The creativity code was observed based on the technology integration learning process. For example, we have coded variations or differences in the resulting ideas as flexibility. Analysis of this data allows us to discuss how student activity on technology-based projects is classified into creativity.

This study also uses structural equation modeling (SEM) analysis to estimate the relationship between constructs and indicators while considering measurement errors (Kock & Hadaya, 2018). This analysis also maximizes the explained variance of the endogenous latent variables. The data used are questionnaires and test data consisting of four construct variables from SUB, six construct variables from AUG, six construct variables from MOD, and four construct variables from RED. On the other hand, FLU has five construct variables, FLE has six construct variables, ORI has six construct variables, and ELA has five construct variables.

RESULTS AND DISCUSSION

SEM analysis shows the results and a more detailed description of how each level of SAMR impacts each creativity indicator: fluency, flexibility, originality, and

Table 1. Reliability & validity of creativity based on SAMR

Creativity	SAMR	Cronbach's alpha	rho$_A$	Composite reliability	Average variance extracted (AVE)
Fluency	SUB	0.875	0.885	0.914	0.727
	AUG	0.927	0.929	0.943	0.733
	MOD	0.935	0.937	0.949	0.755
	RED	0.898	0.900	0.929	0.766
Flexibility	SUB	0.875	0.877	0.914	0.728
	AUG	0.927	0.930	0.943	0.733
	MOD	0.935	0.938	0.949	0.754
	RED	0.898	0.902	0.929	0.766
Originality	SUB	0.875	0.880	0.914	0.727
	AUG	0.927	0.928	0.943	0.733
	MOD	0.935	0.938	0.949	0.755
	RED	0.898	0.899	0.929	0.766
Elaboration	SUB	0.875	0.880	0.914	0.728
	AUG	0.927	0.928	0.943	0.733
	MOD	0.935	0.939	0.949	0.754
	RED	0.898	0.900	0.929	0.766

elaboration. These results align with the analysis of the value of n gain that there is an increase in creativity due to reshaping the use of technology in learning by using the SAMR framework.

The reliability and validity values of the creativity based on SAMR data (**Table 1**) indicate that all the data in SEM analysis have very good reliability and validity.

The reliability of the instrument construction is very good; this is indicated by the Cronbach's alpha value and the rho$_A$ value for all components more than 0.7. The composite reliability of the instrument is also very good because the value for each component is more than 0.7. The instrument's construct validity is very good because the minimum AVE value of each component is more than 0.5. Based on the value of R squared, the variance of endogenous constructions can be explained well by the predictor construction. This model also follows the theory based on the suitability value of the model where the SRMR is less than 0.08 (Elastika et al., 2021; Karwowski et al., 2020). The good reliability of this research data shows that students as respondents and subjects of this study have good consistency. In addition, the questions used also do not contradict each other (Phakiti, 2014). Based on the validity, the items used could construct each research variable. The data from this study also has an excellent ability to make predictions in hypothesis testing (Skains, 2018).

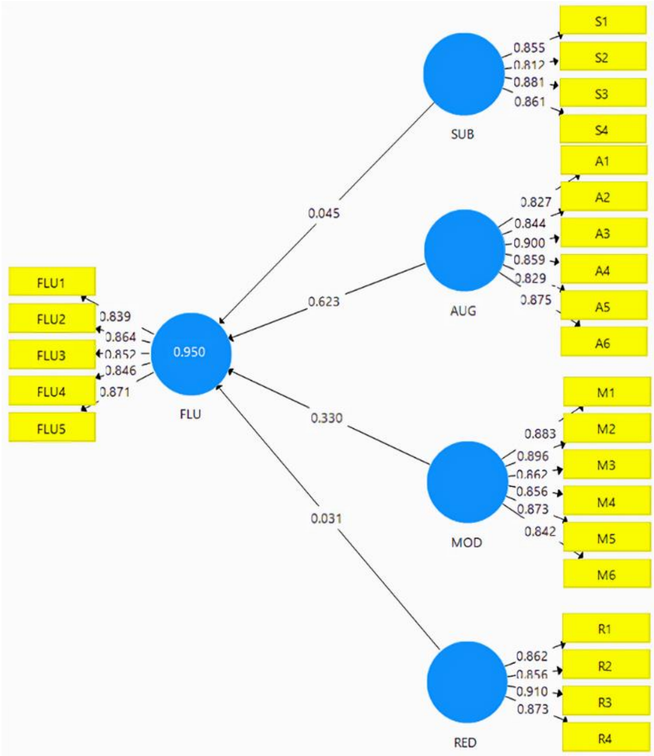

Figure 1. Path coefficient fluency based on SAMR (Source: Authors' own elaboration)

Fluency Based on SAMR

The path coefficient (**Figure 1**) shows that SAMR influences fluency. The strongest to weakest influence is AUG, MOD, SUB, and RED, where all the outer loading data have a minimum value of 0.821 (more than 0.7).

These results align with the squared F and P values (**Table 2**). The F squared values were AUG (2.008; strong), MOD (0.500; moderate), SUB (0.015; weak) and RED (0.006; weak). The p-value also shows a strong relationship between fluency with AUG and MOD, where both values are less than 0.05. From the coding and SEM analysis results, it can be concluded that reshaping the use of technology in learning with the SAMR framework impacts creativity, especially the fluency indicator. Fluency is influenced by the use of technology at the AUG and MOD levels. Torrence (1999) states that fluency is how fluent is individuals in expressing ideas. The more ideas generated; the fluency of the individual is quite high. Technology helps students to get many ideas and analyze or see the advantages and disadvantages of an idea for a solution to a problem (Glaveanu et al., 2020).

Table 2. p, t, & F square creativity based on SAMR

Creativity	SAMR	SD	t	p	F
Fluency	SUB	0.035	1.269	0.205*	0.015*
	AUG	0.033	18.741	0.000	2.008
	MOD	0.034	9.672	0.000	0.500
	RED	0.041	0.770	0.442*	0.006*
Flexibility	SUB	0.045	3.679	0.000	0.212
	AUG	0.043	9.915	0.000	0.963
	MOD	0.049	6.517	0.000	0.490
	RED	0.035	4.938	0.000	0.196
Originality	SUB	0.033	0.943	0.058*	0.007*
	AUG	0.038	15.958	0.000	0.340
	MOD	0.034	1.996	0.046	0.643
	RED	0.035	10.278	0.000	0.821
Elaboration	SUB	0.025	0.434	0.665*	0.001*
	AUG	0.034	0.237	0.813*	0.001*
	MOD	0.037	10.184	0.000	1.070
	RED	0.025	26.166	0.000	4.636

These results align with the squared F and P values (**Table 2**). The F squared values were AUG (2.008; strong), MOD (0.500; moderate), SUB (0.015; weak) and RED (0.006; weak). The p-value also shows a strong relationship between fluency with AUG and MOD, where both values are less than 0.05. From the coding and SEM analysis results, it can be concluded that reshaping the use of technology in learning with the SAMR framework impacts creativity, especially the fluency indicator. Fluency is influenced by the use of technology at the AUG and MOD levels. Torrence (1999) states that fluency is how fluent is individuals in expressing ideas. The more ideas generated; the fluency of the individual is quite high. Technology helps students to get many ideas and analyze or see the advantages and disadvantages of an idea for a solution to a problem (Glaveanu et al., 2020).

Flexibility Based on SAMR

The path coefficient (**Figure 2**) shows that SAMR influences flexibility. The strongest to weakest influence is AUG, MOD, RED, and SUB, where all the outer loading data have a minimum value of 0.816 (more than 0.7). These results align with the squared F and p-values (**Table 2**). The F squared values were AUG (0.963; strong), MOD (0.490; strong), SUB (0.212; strong), and RED (0.196; moderate). The p-value also shows the same thing where 0.000 (<0.05). From the coding and SEM analysis results, it can be concluded that reshaping the use of technology in learning with the SAMR framework impacts creativity, especially the flexibility indicator. The flexibility indicator is influenced by the use of technology at all levels of SAMR. The flexibility is shown by students' ability to generate several ideas with varied patterns (Canton et al., 2021). LMS and social media help students to collaborate and discuss with friends and teachers in providing details and diversity of ideas from the projects (Cummings & Blatherwict, 2017).

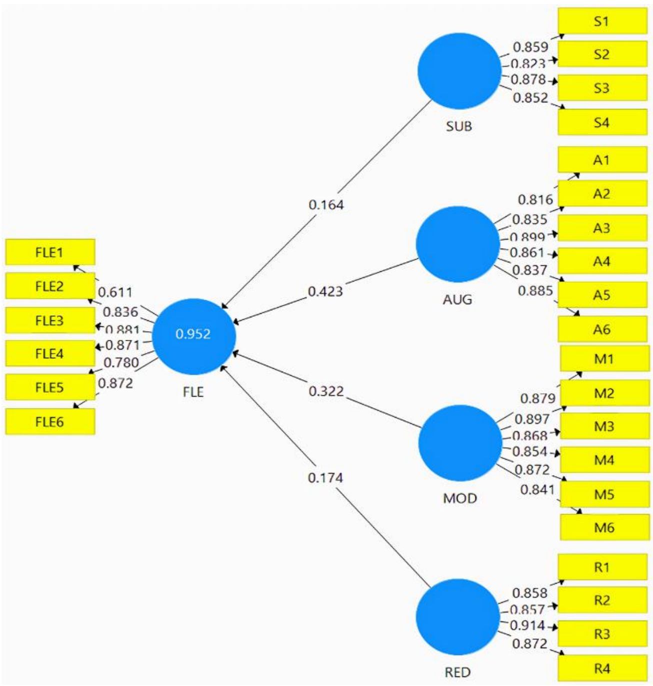

Figure 2. Path coefficient flexibility based on SAMR (Source: Authors' own elaboration)

Originality Based on SAMR

The path coefficient (**Figure 3**) shows that SAMR influences originality. The strongest to weakest influence is MOD, RED, AUG, and SUB, where all the outer loading data have a minimum value of 0.819 (more than 0,7). These results align with the squared F and p-values (**Table 2**). The F squared values were RED (0.821; strong), MOD (0.643; strong), AUG (0.340; strong), and SUB (0.007; weak). The p-value also shows a strong relationship between originality with AUG, MOD, and RED, where the values are less than 0.05. In contrast, SUB has no impact on originality. From the coding and SEM analysis results, it can be concluded that reshaping the use of technology in learning with the SAMR

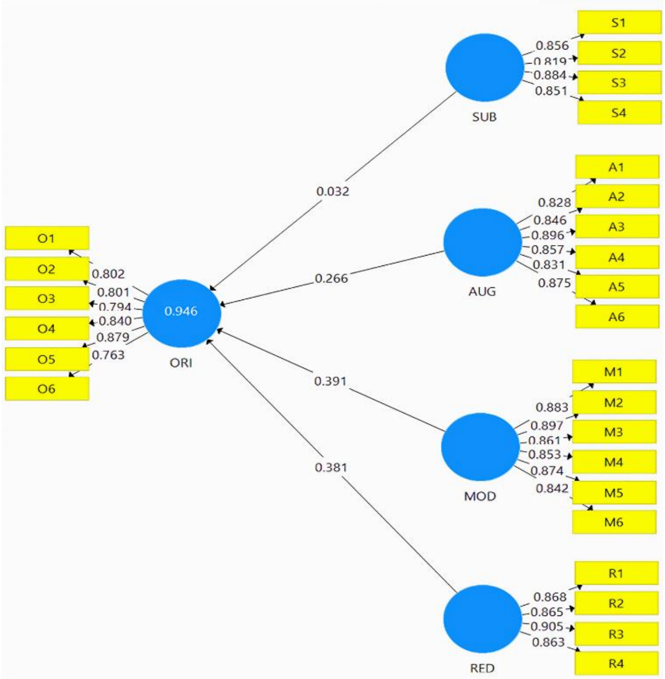

Figure 3. Path coefficient originality based on SAMR (Source: Authors' own elaboration)

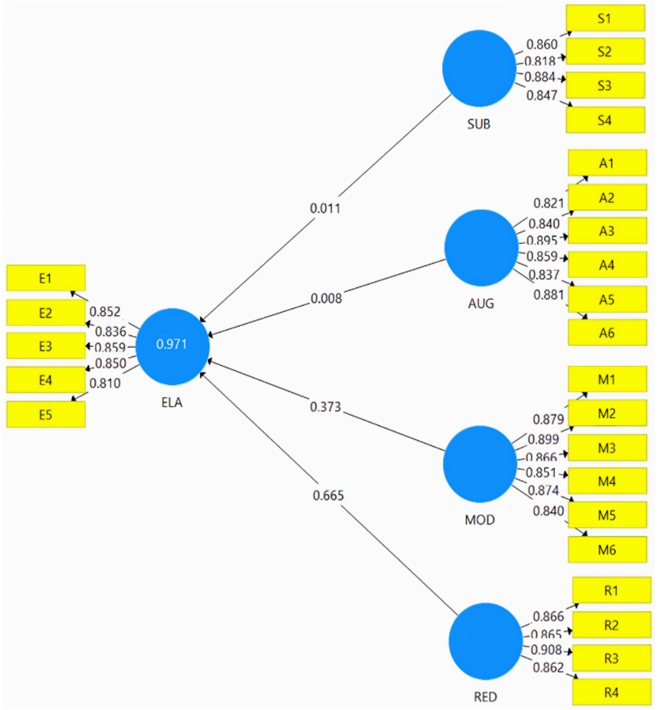

Figure 4. Path coefficient elaboration based on SAMR (Source: Authors' own elaboration)

framework impacts creativity, especially the originality indicator. Originality is influenced by the use of technology at AUG, MOD, and RED levels. Originality is an individual's ability to generate new, unexpected, and unique ideas (Ernawati et al., 2022). The interview results show that some students use Google as a technology to evaluate the originality of their ideas and projects. Using search engines and Google helps students confirm whether the ideas they put forward are already in the public domain so that their originality level increases (Barker, 2019).

Elaboration Based on SAMR

The path coefficient (**Figure 4**) shows that SAMR influences elaboration. The strongest to weakest influence is RED, MOD, SUB, and AUG, where all the outer loading data have a minimum value of 0.818 (more than 0.7). These results align with the squared F and P values (**Table 2**). The F squared values were RED (4.636; strong), MOD (1.070; strong), AUG (0.340; strong), while SUB and AUG have a weak influence (0.001<0.02). The P value also shows a strong relationship between elaboration with MOD and RED, where the values are less than 0.05. From the coding and SEM analysis results, it can be concluded that reshaping the use of technology in learning with the SAMR framework impacts creativity, especially the elaboration indicator. Elaboration is influenced by using technology at MOD and RED levels. Elaboration is the ability to develop and detail ideas (Rubenstein et al., 2020).

From the quality of the details of the resulting project, technology can improve elaboration (Nakano & Wechsler, 2018). Applications and software used in completing projects can provide detailed descriptions of explanations of problem solutions. Technology provides various information and easy access to collaborate on projects rich in information details. Technology also provides various resources for conducting more complex research with multimedia (Hashimi et al., 2019). Students' elaboration ability has increased significantly because students have the freedom to find ideas and develop their basic ideas facilitated by Google Search and Youtube. Collaboration between students and teachers using LMS helps students exchange ideas related to the projects they are working on. The use of LMS facilitates communication between teachers and students to help students solve problems through the scaffolding provided by the teacher (Ma et al., 2013).

Table 3. Creativity n gain results

Creativity indicator	Scores	Criteria interpretation
Fluency	0.465	Moderate
Flexibility	0.715	High
Originality	0.520	Moderate
Elaboration	0.780	High

The analysis results with n gain (**Table 3**) show an increase in creativity due to reshaping the use of technology in learning using SAMR framework. The increase in creativity on the flexibility and elaboration indicators is in the high criteria, while fluency and originality are in the moderate criteria. These results are in line with the coding results (**Table 4**). Flexibility and elaboration are also at the highest percentage, while fluency ranks third. The use of technology influences this result, although the percentage value is not too much

Table 4. Results of SAMR coding & creativity

SAMR vs. creativity	Substitution	Augmentation	Modification	Redefinition	Total	Percent
Fluency	3	12	13	5	33	22.76
Flexibility	8	18	14	10	50	34.48
Originality	2	11	7	8	28	19.31
Elaboration	7	5	9	13	34	23.44
Total	20	46	43	36	145	100.00
Percent	13.79	31.72	29.65	24.83	100.00	-

different from the elaboration. We identified that its development and technology use largely influences the fluency indicator. The coding results (**Table 4**) show that the level of augmentation and modification has the most significant influence on creative exploration.

Observations and interviews proved that 85% of students were actively involved in generating and analyzing ideas during the project. By integrating all the data, we can connect the levels of SAMR, technology-based projects, and creativity. Furthermore, the relationship between coding on the SAMR and its relationship with creativity (**Table 4**) shows that in terms of creativity, elaboration has the highest percentage and the lowest originality. Meanwhile, the level of modification on SAMR has the most significant implication on students' creativity, while the substitution level has the least impact. Teachers use LMS to provide articles (.pdf), videos, links, and trusted websites to find information and explore ideas, so students are free to collaborate to carry out various explorations in completing projects. Some groups of students can even maximize their use of technology and learn new software to complete projects. Combining project-based learning and technology can increase students' understanding of a concept and theory because students and educators can extract direct feedback from each other, which has an impact on students' creative skills (Capraro et al., 2016; Han et al., 2015; Lou et al., 2017).

The teacher's role is to provide direction regarding the technology used at the substitution, augmentation, and modification levels. However, at the redefinition level, teachers give students the freedom to use technology to complete projects. Teachers play a vital role in reshaping the use of technology in learning, influencing how students can improve their creativity (Apriwanda & Hanri, 2022). There are variations in the technology used between groups of students depending on their project needs. The choice is influenced by collaborative activities, student motivation, and creativity. At the same time, the technologies that are most often used are laptops and smartphones. In the results of this study, the teacher's instructional instruction for learning will be explained when we analyze the function and complexity of creativity. Regarding creativity, students' skills can be honed through project-based learning because it requires critical thinking, creative thinking, time management skills, and the ability to work together to solve problems (Tan & Chapman, 2016). Generally, technology-based projects can add to learning skills and real-world experiences.

Reshaping technology in learning impacts creativity (**Table 5**) and the quality of their projects. The most extreme results in this study appear at the redefinition level. Students study applications and software independently to analyze environmental conditions based on the problems given. The technologies used by students are Origin 8, Progress3, Res2DIV, and IP2Win software, which allow them to identify subsurface conditions (Ayu & Sarwanto, 2019; Jufriadi & Ayu, 2019). By knowing subsurface conditions, they can identify the relationship between physical principles and soil characteristics in drought. Subsurface conditions are impossible to detect with the naked eye, so technological intervention is required.

Researchers identify the importance of technological intervention in completing projects that require creativity. In this section, the patterns and implications of the findings, which are the untapped potential of the technology on projects about creativity, will be discussed further. Despite the limitations of our study, we can conclude the importance of our future research on learning, creativity, and technology. Using Google Search and YouTube, a modification level, helps students explore, discover, and experiment when answering problems so that the quality of projects reflects increased creativity (Hoffmann et al., 2016). The balance between logic and creativity is crucial. Creativity will be ignored if one puts too much logical deduction (Pheeraphan, 2013). Thus, to bring out creativity, freedom of thought is required. Students should not be under control and pressure. Student's fluency in using various technologies leads to better and unpredictable work quality and different solutions to each problem because students are given the freedom to explore problems and think independently. Students not only have fluency in generating many problems from a situation but can also develop fluency by generating various solutions (Haase et al., 2018). In line with the results in **Table 1**, fluency is in a good category. In this way, students can be conditioned to generate new solutions through collaboration. The level that occurs in this activity is augmentation.

Using open-ended essential questions requires students to guess, make hypotheses, check whether they

Table 5. Relationship between SAMR & creativity

Level of SAMR	Creativity
Substitution: MS Word, Whiteboard App, & Website SAMR	Flexibility • Providing various interpretations of a picture, story, & problem • Applying a concept or principle in a different way
Augmentation: Google Doc, Canvas, Google Slide, Zoom, & WhatsApp	Fluency • Having lots of ideas Flexibility • Thinking of different ways to solve essential questions • Being able to change direction of mind spontaneously after getting scaffolding Originality • Having a different way of thinking than others in solving essential questions • Prioritizing synthesis over situation analysis
Modification: SPADA, Google Classroom, Google Search, & YouTube	Flexibility • Classifying the information obtained according to different categories Elaboration • Developing & enriching the ideas of others • Trying & testing details to solve essential questions • Looking for a deeper meaning to the answer to the essential questions • Possessing a strong sense of beauty & are not satisfied with appearance of simple projects • Adding a detailed description of the project Fluency • Fluently expressing ideas • Quickly noticing the errors & shortcomings of an object & situation • Considering situations that differ from those given by others
Redefinition: Progress3, Res2DiV, IP2Win, & Animaker	Flexibility • Providing a variety of unusual uses for objects Originality • Questioning old ways & thinking of new things • Looking for a new approach to the stereotype

are true, review their solutions thoroughly, and draw conclusions guided by the teacher. The teacher can provide scaffolding intensively with the help of LMS (Haase et al., 2018). Based on SAMR in this study, LMS is applied at the level of modification through SPADA and Google Classroom. Scaffolding through collaborative activities using LMS-assisted teachers is a form of creativity in a social environment (Ahmadi & Marandi, 2014). The cognitive processes needed to carry out activities through LMS, such as by attending virtual meetings via Zoom, illustrate that students learn to solve problems and learn new concepts or ideas collaboratively. It allows a 'creative' process to develop, shape, and modify new ideas on both a psychological and sociological level (Wang et al., 2016). This condition can contribute to increased flexibility compared to other creativity indicators (**Table 2**, **Table 4**, and **Table 5**). This technology support can help students produce more detailed assignments in terms of the quality of the discussion and the information (Ayu et al., 2021). It causes the flexibility indicator to be the level most influenced by SAMR.

In our study, creating project assignments with technological interventions increased creativity. The most optimal project task in this research is at the level of redefinition. Technology (LMS, Zoom, and Google Meet) is proven to play a role in developing creativity on campus. However, our data show that the substitution level does not have many implications on creativity (**Table 2**, **Table 4**, and **Table 5**) because the technology used is only a substitute for instructional learning, and there is no change in function. The use of technology in uncomplicated learning will not have an impact on students' creativity (Glaveanu et al., 2020).

Reshaping technology-based learning with the SAMR framework shows that the elaboration criteria do not correlate much with the use of technology (**Figure 5** and **Table 5**). The freedom to use technology as a source of information and communication media tends to give students a navigational tool to develop their ideas. However, students are sometimes tempted to plagiarize, not produce original products, and come up with ideas instantly without exploring possible thoughts in their group. They believe that ideas on the Internet are better and guaranteed to be correct. In addition, not all students can find reliable learning resources. They sometimes focus too much on the content of the website and do not see if the website can be trusted or not, which influences how creativity can be explored (Mbatha, 2013)

Reshaping in this research can evaluate and explore the integration of technology in learning. The results show that technology can be used as a resource and tool to support the development of 21st century learning

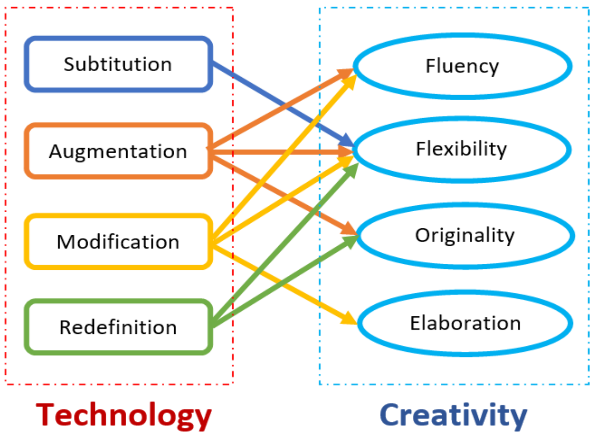

Figure 5. Relationship between SAMR & creativity (Source: Authors' own elaboration)

skills such as collaboration and creativity (Taylor et al., 2020). Research findings indicate that in addition to technology, teacher instructional skills, student motivation, and independence are needed to optimize creativity exploration. Technological interventions enable teachers and learning to adapt to the pedagogical developments and skills demands of the 21st century. It makes perfect sense to integrate SAMR into learning with an explicit instructional pedagogy (Onyango & Gitonga, 2017). Our data show that all indicators of creativity can be explored and improved. The achievement of each creativity indicator is also influenced by the technology used at the SAMR level (**Table 5** and **Figure 5**).

Although this study may serve as an initial hypothesis to inform future designs, it has limitations on the number of subjects and the location of the subject areas. This research also only looks at creativity as a process of activities and products based on creativity indicators. Aspects of how the stages of the process of achieving individual creativity are not explored prevent us from seeing how the phases and steps of learning integrated with SAMR can impact the stages of developing students' creativity. With this information, teachers can immediately provide feedback on the learning process so that students' creativity can be more optimal (Gube & Lajoie, 2020)

Our research leaves the question of how the technology used with appropriate instructional support can impact each stage of an individual's creative development. We see the need for further research to investigate how teacher decisions about technology choices are made to evaluate their impact on students' learning, critical thinking, and collaboration skills (Such, 2022). For projects, our findings reveal that technology is only a medium for finding information that the teacher does not provide. Improper use of technology can be a problem, especially regarding plagiarism (Ogbonna et al., 2019).

CONCLUSION

The use of technology alone does not fully impact students' creativity, but how instructional learning also influences it. Reshaping learning using technology with SAMR framework explores students' creative skills, especially the flexibility aspect. The SAMR level that has the most impact on students' creative skills is the modification level. The teacher's skills as a learning facilitator will determine how technology can be used in working on projects efficiently to explore students' creativity. If the teacher is not skilled, technology is often used as a substitute for traditional instructional tools.

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Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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