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# A Comparison of Science Learning Skills in the Teacher-centered Approach and Inquiry-based Science Fieldwork: Primary School Students' Perceptions

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## Abstract

This paper describes and compares primary school students' perceptions of science learning skills in a teacher-centered approach (TCA) and in inquiry-based science fieldwork (IBSF). This comparison was prompted by primary school students' perceptions of science learning skills, which has recently gained momentum, and the Namibian primary schools' recent curriculum shift from TCA to IBSF. The study utilized quantitative cross-sectional data (n = 237) collected from two primary schools in the Oshana region of Namibia. The data were gathered via an online survey and were analyzed using descriptive statistics. The Mann–Whitney U test was used to compare the TCA and IBSF groups. The results revealed that the students had positive to fairly positive perceptions of science learning skills in IBSF and very negative to negative perceptions of science learning skills in TCA, with the difference between the two perceptions being statistically significant. This may indicate that Namibian primary school students find it hard to develop science learning skills under TCA. Therefore, the current study provided evidence for the need to focus more on supporting students' science learning skills, particularly problem-solving, communication and teamwork skills. This implies that the IBSF teaching approach, which allows students to become aware of the importance of science learning skills, must be adopted in Namibian primary schools. The paper also discusses the benefits of IBSF of science learning skills in students.

## Introduction

There is no doubt that science education has brought remarkable changes worldwide to students' perceptions of the importance of science learning skills (Pakombwele & Tsakeni, 2019). 'Learning skills' is a term used to describe the numerous skills needed to acquire knowledge and understanding, particularly in a formal learning setting, such as a school (Higgins et al., 2007). Engaging students in science education and developing their science learning skills are of national and international concern (Kambeyo & Csapó, 2019). Thus, investigations of students' perceptions of science learning skills have been conducted, and the results differ based on the subject content, learning competencies and teaching approach used. It has been found that science students frequently only aim to acquire knowledge of the subject content, without mastering the learning skills involved (Kasanda et al., 2013). This means that science students do not always understand science education thoroughly, which poses a threat to their learning skills (Pietrocola et al., 2021). A shift from memorizing science terminologies to understanding scientific ideas has thus become a central effort in modern science education (Zvoch et al., 2021).

Science education involves various approaches that teachers utilize in their lessons. Some examples of these are problem-based learning (Fettahlıoğlu & Aydoğdu, 2020), student-centered education (Mavhunga & Rollnick, 2016), inquiry-based learning (van Uum et al., 2021), science fieldwork (Kervinen et al., 2018) and the teacher-centred approach (Al-Zu'be, 2013). However, there is no unique consensus about the effectiveness of these approaches in developing students' science learning skills. The current study focused on the teacher-centred approach (TCA) and on inquiry-based science fieldwork (IBSF) is regarded as an instructional practice where students are at the centre of the learning experience and take initiative in and ownership of learning by asking questions, investigating and answering their own questions on the field or site to achieve a particular learning outcome (Odhiambo 2022).

In the following sections, we briefly examine the two aforementioned teaching approaches in science education. Science learning skills are dealt with separately, they can be targeted in both TCA and IBSF. The current study seems unique in the Namibian context as it was conducted in the primary school setting, whereas most of the previous studies were conducted in the secondary school setting. The current study was also conducted in the context of the revised Namibian curriculum as well as other countries which revise their curriculum in science education (Fensham, 2022).

## Teacher-centered Approach and Inquiry-based Science Fieldwork in Science Education

Teaching approaches refer to the ways teachers deliver lessons to their students to develop in them the subject learning competencies reflected in the syllabus (Gill & Kusum, 2017). In TCA, teachers deliver lessons to their students by talking or perhaps showing slides while the students listen and take notes (Baepler et al., 2016). Thus, in TCA, teachers are at the center of the learning process, directing it themselves (Zvoch et al., 2021). In a study conducted by Sajjad (2010) with higher education students, most students evaluated TCA as the best teaching approach because the teacher provides all the information related to the topic while the students just thoughtfully listen and take notes, making the learning process effective. Opdecam and Everaert (2019) also found that primary school students favor TCA because they regard it as a good approach for examination and test preparation. This resonates with science education in Namibian primary schools, where students are expected to take examinations every semester or annually as a form of assessment for promotion to the next grade (Kambeyo & Csapó, 2019). TCA is also imperative in education (Ruzikulovna, 2021) and is deemed favorable and interactive when used by a charismatic teacher (Winkler & Rybnikova, 2019). Hence, the current study examined students' perceptions of science learning skills development in TCA.

The Namibian primary science curriculum has undergone many remarkable changes over the last decade (Shinana et al., 2021). These changes have exposed the limitations of TCA in attaining skills-related learning objectives, such as helping students learn to communicate well and solve problems. According to Dominici (2022), TCA is also poor at promoting critical thinking among students and attending crowded science classes in which TCA is used has an overall negative bearing on student learning. For instance, the aforementioned scenario may cause the teacher to pay attention only to some students, and the other students who are deprived of the teacher's attention tend to lose interest in the subject quickly. The criticisms of TCA also point to the fact that teachers do not utilize all the teaching aids for the lesson, nor does it fully grant students an opportunity to include new information in their prior understanding (Kambeyo & Csapó, 2019). However, TCA has remained one of the most prominent teaching approaches still used today because it succeeded in changing and promoting independent thinking and motivation of learners, as shown by empirical evidence (Malecka & Boud, 2021).

TCA is not always seen as the most relevant in science education, and more emphasis is put more on learner-center learning approaches to support students (Kambeyo & Csapó, 2019). Notwithstanding the above, students can adopt other approaches, such as inquiry-based learning (IBL). IBL relates to the constructivist approach, where students construct their own knowledge (Kaya & Avan, 2020). IBL involves seeking knowledge and new understanding in science lessons (Pedaste, 2015) such as using environmental materials to understand science learning skills. Under the IBL approach, there is IBSF which is an instructional practice that involves students conducting investigative work outside of the classroom environment to achieve a particular outcome (Cheng 2022). For instance, having an understanding that plants lose water via their leaves, learners could use plastic bags to cover the leaves and investigate the water droplets captured in the plastic bags as produced by the leaves. In IBSF, learners can pose questions, and are at the center of the learning experience (Kervinen et al., 2018), and become self-directed investigators (Zvoch et al., 2021; Cheng 2022). Furthermore, teaching and learning via the IBSF approach adds value to comprehension of science concepts and finally, improves students' academic success (Penn et al., 2021). However, IBSF also has a few challenges (Vries et al., 2017), such as preparation and sensitivity towards the environment (Chalmeau & Julien, 2022), and finding time to practice it (Li & Sullivan, 2016; Kang, 2020). Li and Sullivan (2016) indicate that all IBSF activities take time to prepare and to manage because great care must be taken to mitigate possible physical risks to students for them to work safely and equally prevent risks associated with the outdoor environment. These challenges result in some students not paying attention in class and negatively perceiving the approach.

## Students' Perceptions of Science Learning Skills in the Context of TCA and IBSF Approaches

In the current study, the perceptions of students refer to their views towards different approaches. Having positive views on science approaches is significantly crucial to attain the objectives in science curricula, such as understanding the interaction of human-environment, solving problems between science and society (Payton et al., 2008). Science education includes procedures of how students' reasoning and expressing their perceptions are interrelated (Sampson & Clark, 2009). This interpretation is necessary to understand instruction in science education about "what we know" and "how we know", and "why we believe what we know over alternatives" (Duschl & Duncan, 2009, p. 311). This includes science learning skills that allow students to simultaneously process information that seems valid to their investigation about science. Tortop (2015) reported that students have skill management to utilize resources effectively and achieve learning outcomes. Moreover, Opdecam and Everaert (2019) stated, that students who prefer and want to work on their own desire to use TCA compared to other students who are more collaborative and prefer IBSF. Furthermore, information skills refer to the search for knowledge, for example through digital sources, manage documents and emails in order to evaluate usefulness and relevance of it (Chu et al., 2011) to students. Information skills were highlighted by Gürsoy (2021), who considers it an integral skill which provides expressive and enduring learning that is entertaining.

Problem-solving skills is described in the study of Meilinda (2021) as a person's ability to engage in cognitive processes when trying to comprehend and solve science problems, and it is one of the most important skills provided to learners because it trains their ability to think in both TCA and IBSF. In addition, several authors (Mistry et al., 2006; Jang, 2010; Kulgemeyer, 2018) view that communication skills allow learners to understand, present as well as make decisions or negotiate, for example, when conducting scientific experiments and investigations. Moreover, Mayowski et al. (2019) outlined that team skills are designed to foster collaboration among students. Collaboration in science education has several benefits such as social, psychological and academic for students. Social benefits which lead to build a variety of understanding among students and establish a positive learning atmosphere, psychological benefits which reduce anxiety among students and academic benefits which involve students active learning process (Laal & Ghodsi, 2012). Lastly, inquiry skills in science education refers to the ability of students to formulate questions and hypotheses, plan investigations and draw conclusions (Pedaste et al., 2012).

Most of the above-mentioned science learning skills and the significance of those skills have been investigated especially in higher education (see, e.g., Mistry et al., 2006, Rydant et al., 2013). According to Mistry et al. (2006) these science learning skills have effect on higher education students' development in science courses. These skills have been seen crucial especially in field work (Rydant et al., 2013). Considering the relevant science learning skills, the Namibian 7$^{th}$ -grade INSHE revised curriculum introduces some IBSF skills. The science education curriculum requires students to exercise the ideas of developing questions, observation, making hypotheses and predictions, collecting data, measuring, interpreting findings and making conclusions (Namibia, INSHE 2016). This study concentrates on seven skills, as shown in Table 1, in both teaching approaches. We have modified geographic skills in Rydant et al. (2013) to inquiry skills as the context of our study is biology.

Table 1. Science Learning Skills and the Descriptions (adapted from Rydant et al., 2013; Mistry et al., 2006; Pedaste, 2015)

| **Skills** | **Descriptions** |
|---|---|
| Management skills (MS) | The ability to work to a deadline of a task. Essential that learners must plan the allocation of resources in a lesson. |
| Learning skills (LS) | Involves students' passion, sensitivity and networking to science topics. Basically, how learners use their prior knowledge to make sense of new learning experiences. |

| Skills | Descriptions |
|---|---|
| Information skills (IS) | Understanding of the schoolwork environment. Students must take the initiative and are motivated for the right reasons to consider the skills. |
| Team skills (TS) | Involves the ability of learners to share each other's knowledge and skills and work collaboratively in class. |
| Problem-solving skills (PSS) | Ability to find solutions to ongoing challenges and develop strategies to change mindsets. |
| Communication skills (CS) | Involves the ability to present and make decisions. |
| Inquiry skills (IqS) | Emphasizes students' active participation and taking responsibility for discovering knowledge that is new to them. |

This paper reports on students' perceptions of science learning skills after two teaching approaches. Therefore, the following research questions are addressed:

1. What are the primary school students' perceptions of science learning skills after teacher-centered approach and inquiry-based science fieldwork?
2. To what extent do primary school students' perceptions of science learning skills differ in teacher-centered approach and inquiry-based science fieldwork?

## Method

### Research Design

This study followed the descriptive and comparative study design. The study aimed to explore the students' science learning skills after two different teaching approaches and compare how students' perceptions differ between these two different experienced approaches. By descriptive design, the study aims to increase the understanding of students' viewpoint of science learning skills after participation in instruction. On the other hand, by using the comparative design the study provides more options to develop teaching approaches in Namibian context. TCA approach is more commonly used, but there is lack of studies in IBSF in Namibia.

### Measures

***Survey of Students' Perceptions of Science Learning in TCA and IBSF***

Primary school students were requested to respond to an equivalent series of statements (see appendix 1) designed to capture their perceptions of science learning skills after TCA and IBSF. Hence, a previous survey of the study by Rydant et al. (2013) was modified according to learners' perceptions of science learning skills in TCA and IBSF (see Appendix 1), the initial instrument comprises of 46 statements, but we only chose 25 items that were relevant in study context, and which primary learners could complete within a given time. The initial survey focused on geography fieldwork and our study on science education fieldwork. That is why the original item geographical skill was changed to inquiry skills (IqS) due to the research at hand. The number of items per skills were arranged as follow; MS= 5, IS= 3, TS=4, PSS=3, LS=3 and SS= 4 and IqS=3. The survey was online, which students filled out individually. Moreover, a survey used a Likert scale with a five-choice model, which consisted of the criteria; 1-Strongly disagree, 2-Disagree, 3-Neutral, 4-Agree and 5-Strongly agree.

**Participants and Procedures**

The demographic information of primary school students who participated in the study is given in Table 2. It describes their age, gender and number of times they were in 7$^{th}$ -grade.

Table 2. Demographic Information of Participants

| **Items** | **TCA f (%) n= 137** | **IBSF f (%) n=100** |
|---|---|---|
| **Age** | | |
| • 12 years | 49 (35.7) | 43 (43) |
| • 13 years | 59 (43.1) | 37 (37) |
| • 14 years | 18 (13.1) | 17 (17) |
| • Older than 14 years | 11 (8.1) | 3 (3) |
| **Gender** | | |
| • Boys | 71 (51.8) | 45 (45) |
| • Girls | 66 (48.2) | 55 (55) |
| **Number of times in 7$^{th}$-grade** | | |
| • First time | 117 (85.4) | 80 (80) |
| • Second time | 20 (14.6) | 20 (20) |

Data was collected during the spring 2022 from Oshana region in Namibia. Totally 237 primary school 7$^{th}$- grade science students participated in the study, whereby 137 students took part in the TCA and 100 students in IBSF. The participants were selected by using purposive sampling to be able to collect data within two different teaching approaches based on voluntary participation. The survey measure was piloted with 7$^{th}$-grade students in fall 2021 to minimize the measurement error and to verify the suitability of the survey for primary school students. The pilot data (N= 50) was analyzed to indicate the good internal reliability ($\alpha$ >.70) of the items.

Data collection was implemented in two classrooms in which TCA approach and IBSF teaching approaches were applied. In both approaches, students studied the same content based on plants, animals and ecosystem (see Appendix 2). These topics are from the Namibian 7$^{th}$-grade science syllabus. Therefore, 12 lessons, two lessons per topic, were taught to students in both groups.

Students in TCA were taught in the classroom where else students in IBSF were divided into groups of five and went out to the field with the teacher's guidance to collect information regarding the above-mentioned topics and discuss their findings in the classroom. Students responded to the survey after the teaching period individually using school computers. Totally 15-20 minutes were used for completing the survey. The research ethics guidelines (see Finnish National Board on Research Integrity, 2019) were followed during the data collection. Consents from different stakeholders were received and all students participated in the study voluntarily. Students' anonymity was secured, and no harm was created.

**Data Analysis**

The data was analyzed using Statistical Package for Social Sciences (SPSS) 25.0 versions software package. To respond to the research questions, the descriptive statistics were used to describe the learners' perceptions and Mann-Witney U test compare the differences in students' perceptions between two different teaching approaches. The Cronbach's alphas (α) of TCA skills values ranged from .83 to .66 (Table 3). However, it was not good in inquiry skill (IqS) as it represents an α of .66. The total Cronbach's alpha for all the skills was .967 showing each scale's strong internal reliability (over .70) (Muijs, 2011). The results also indicate a total low mean of TCA (M= 63.06, SD =17.17), and students' perceptions of science learning skills had a skewness = .755 (SE = .213), kurtosis = .238 (SE = .423). Furthermore, the data for TCA was normally distributed. The Cronbach's alpha for IBSF skills factors after IBSF values ranges from .85 to .66. The total Cronbach's (α) alpha for all the perception of learning skills was .954. This shows each scale has a strong internal reliability because it is over .70 (Muijs, 2011). However, the Cronbach's alpha was fairly good in problem solving skills (PSS) as it stood at .66 (Table 4).

## Results

### Students' Perceptions of Science Learning Skills after TCA

An arbitrary point was used to interpret the overall rating of students' perceptions of science learning skills (cf., e.g., Ganeb & Montebon, 2018). The overall arbitrary point is interpreted as; 4.2-5 very positive, 3.5-4.1 positive, 2.4-3.4 fairly positive, 1.6-2.3 negative and 1-1.59 very negative. The descriptive results in Table 3 indicate primary science students' perceptions of science learning skills in TCA.

Table 3. Descriptive Statistics of Students' Perceptions of Science Learning Skills after TCA

| **Skills** | **M** | **SD** | **α** | **Perceptions** |
|---|---|---|---|---|
| Management skills (MS) | 1.88 | 2.68 | .83 | Negative |
| Learning skills (LS) | 1.46 | 2.10 | .79 | Very negative |
| Information skills (IS) | 1.43 | 2.19 | .79 | Very negative |
| Team skills (TS) | 1.98 | 2.89 | .82 | Negative |
| Problem-solving skills (PSS) | 1.55 | 2.38 | .81 | Very negative |
| Communication skills (CS) | 1.97 | 2.92 | .81 | Negative |
| Inquiry skills (IqS) | 1.40 | 1.80 | .66 | Very negative |

The outcome specified that students did not perceive to gain science learning skills well in general. They rated all skills rather negatively especially inquiry skills (M= 1.40, SD = 1.80), information skills (M= 1.43, SD= 2.19) and learning skills. (M= 1.46, SD= 2.19) (Table 3). However, a bit more positively students' perceived management skills (M= 1.88, SD= 2.68), team skills (M= 1.98, SD= 2.89) and communication skills (M=1.97, SD=2.92). However, the standard deviation indicated there are variation among the students' perceptions. Students' perception of science learning skills in TCA were most negative (M= 1.40, SD = 1.80) in Inquiry skills compared to the rest of the skills. This result signifies that inquiry skills in TCA cannot support students' perceptions to design their field-based investigations or develop their interpretation skills to solve scientific problems. Furthermore, the results are presented as M = Mean; SD= standard deviation; α = Cronbach's alpha (see Table 3).

**Students' Perceptions of Science Learning Skills after IBSF**

The results of students' perceptions of learning skills after IBSF indicates mainly fairly positive perceptions in general. students had a negative skewness = -.649 (SE = .243), kurtosis = -.262 (SE = .481), which shows that data was not normally distributed, but slightly negatively distributed. In Table 4. the results indicate positive perceptions of science learning skills in skill management (M= 4.06, SD 2.52) and a fairly positive perception in science learning skills (M= 2.22, SD = 1.67). Overall, primary science students indicates that they have a positive perceptions of learning skills towards IBSF (see Table 4). The results of students' perceptions of science learning skills in IBSF indicate that management skills had a highest mean (M= 4.06, SD = 2.52) than the rest of the skills. This implies that students in IBSF have the ability to manage time, capacity to judge oneself more clearly and set goals in science education. Furthermore, the results are represented as M= Mean; SD = Standard deviation; α = Cronbach's alpha (see Table 4).

Table 4. Descriptive Statistics of Students' Perceptions of Science Learning after IBSF

| | M | SD | α | Perceptions |
|---|---|---|---|---|
| Management skills (MS) | 4.06 | 2.52 | .74 | Positive |
| Learning skills (LS) | 2.52 | 1.71 | .76 | Fairly positive |
| Information skills (IS) | 2.48 | 1.66 | .76 | Fairly positive |
| Team skills (TS) | 3.35 | 1.90 | .70 | Fairly positive |
| Problem solving skills (PSS) | 2.49 | 1.42 | .66 | Fairly positive |
| Communication skills (CS) | 3.25 | 2.43 | .85 | Fairly positive |
| Inquiry skills (IqS) | 2.44 | 1.67 | .71 | Fairly positive |

**Differences between Students' Perceptions of Science Learning Skills in TCA and IBSF**

Since data was not normally distributed in IBSF, we opted to use a Mann-Whitney U test for comparing students' perceptions of science learning skills after two teaching approaches. Table 5 indicates that students' mean rank in IBSF was greater (Mdn = 182.99) than TCA (Mdn = 72.29), U = 451.00, p < .000, r = -1.05 with a small effect size. That means students agreed with the perception of science learning skills in IBSF compared to TCA. This could be because students were able to judge themselves more clearly, learn, to take responsibility for their own learning. Therefore, the results are represented as significant at 0.05 level (2-tailed). Effect size: r less than 0.3 -> small effect. Effect Size r between 0.3 and 0.5 -> medium effect. Effect Size r greater than 0.5 -> large effect

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Table 5. The Comparison of Students' Perceptions of Science Learning Skills in Teacher-centered Approach and Inquiry-based Science Fieldwork

| **Approaches** | **N** | **Mean rank** | **Mann-Whitney U** | **Z-value** | **p** | **r** |
|---|---|---|---|---|---|---|
| TCA | 137 | 72.29 | 451.000 | -12.279 | .000 | -1.05 |
| IBSF | 100 | 182.99 | | | | |

## Discussion

This study aimed to describe and compare Namibian primary school science students' (7th -grade) perceptions of science learning skills after two different teaching approaches, teacher-centered approach (TCA) and inquiry-based science fieldwork (IBSF). In this study, students' perceptions of science learning skills were rather negative after TCA and mostly positive after the IBSF teaching approach. Negative results are in contrast with the study of Teppo et al. (2021), which indicated that primary school students have a positive and significant association to TCA, the increase in the frequency of TCA activities practiced in science classes resulted in higher student interest and enjoyment in science learning, in comparison to negative results of this study.

Positive results after IBSF are in line with the study of Aditomo and Klieme (2020), which scrutinized the Program for International Student Assessment (PISA) in 2015 where they tested the assumption of measurement invariance across regions, and disclosed that the effect of inquiry-based instruction on students learning outcomes were from teacher guidance showed positive results, therefore inquiry-based instruction is considered as one of the best teaching and learning approaches because it has a positive impact on the development of knowledge, skills and attitudes for twenty-first-century education, suggesting that both teaching and learning approaches have a role to play in students' learning process and so that students can master the competencies effectively and efficiently. Students' perceptions of learning management skills, such as the ability to manage time, and the capacity to judge oneself more clearly and set goals in science education, were negative after TCA but positive after IBSF. This may be because IBSF students are studying by approaching student-centered and need to take more responsibility for their studies (see also Kervinen, 2018). However, in TCA, the teacher takes more charge and students are mainly listeners to the teacher's explanations and have no chance to practice the creativity of their minds (Salamah, 2023). Similar findings were found with students in science education, e.g., in the study of (Ndjangala et al., 2021). This may be because TCA did not offer explicit training on managing own work when necessary (Mistry et al., 2006). This study's negative results in management skills in TCA are in contrast to Ndjangala et al. (2021) study, which outlined students have management skills to utilize resources effectively and achieve the learning outcomes in TCA. However, our findings highlighted that students had a positive perception towards management skills in IBSF and they are in line with Kervinen et al. (2018) results which show that instructional strategies allow students' sense of freedom to be balanced against controlling practices so that the initial uncommon setting is transformed into ordinary schooling for student. Additionally, IBSF results also aligned with the study of Cantine (2021); Li and Sullivan (2016) indicated that in order for work safely and prevent outdoor environmental risks, all fieldwork should take time to prepare and manage to prevent physical risks.

We also found out that primary science students' perceptions of learning skills in TCA remain a concern in learning skills. Although the students perceived the science learning skills negatively after TCA, they rated communication and team skills a bit better, this could be because students are able to assist and take responsibilities of their learning during team skills. Students' perceptions of learning skills in IBSF were more positive than TCA, therefore, our study results aligned with the studies conducted by Cremin et al. (2015), which pointed out that IBSF is imperative and valuable to students because it allows them to be critical thinkers, problem solvers and interpreters of results. Positive learning skills after IBSF emphasize what, how and why students know science content (Duschl & Duncan, 2009). Not only that but all the items are positively associated with students' perceptions of learning skills in IBSF. Hence, it can be concluded that IBSF moderately contributes to students' science knowledge, self-directed, inquiry-oriented fieldwork in the natural environment (cf., Jong, 2020). These results can be aligned with the study of IBSF by Penn et al. (2021), which outlined that fieldwork positively contributes to developing scientific skills, learning, and understanding of scientific concepts that eventually lead to students' academic success. However, Fitzgerald et al.'s (2019) study contradicts these findings because they suggested that fieldwork does not offer students the scaffolds needed to acquire specific concepts or the processes of science. The choice of animals, plants, and ecosystems as the focus of fieldwork was suitable. It allowed students to engage with the natural world and understand the complexity and interdependence of living organisms and their environments. Through IBSF, students were able to observe and document the behaviors, interactions, and adaptations of different species/this approach allowed students to engage in inquiry-based learning, develop important scientific skills, and gain a deeper understanding of the natural world.

TCA also seems to provide opportunities for social interactions to develop skills to work with others. However, these skills should be considered more carefully in TCA since the teacher is the one to guide students through this approach. Moreover, information skills in TCA which showed negative results indicated that students did not highlight the importance of information skills in this study which may be because they represent a new generation in which learning skills are self-evident and not necessarily passed on from the teacher to them, these results are in contrast with the study of Nasikhah et al. (2022) which considered information skills significant in data gathering and critical thinking, which are crucial in science learning, for example to find information on school assignments, especially natural science materials related to the reproduction of living things.

This study negative results in team skills after TCA is in contrast with the previous findings of Sairam et al. (2017), which confirms that team skills can be fostered through engaging students in tasks which develop their interaction with diverse others. Although, TCA also provides opportunities for social interactions to develop these skills to work with others, these skills should be considered more carefully in TCA. In this study, students perceived to gain problem-solving and inquiry skills only after the IBSF teaching approach. The students' positive perceptions after IBSF can be understood with Afandi et al.'s (2018) study which suggested that science education aims to improve students' problem-solving skills to solve scientific problems; therefore, students are encouraged to be independent, creative, and problem-solvers. It seems that TCA did not provide options to solve problems neither experience inquiry skills such as observation, comparing, classifying and measuring (see e.g., Pakombwele & Tsakeni, 2019); therefore, they had negative perceptions towards problem-solving skills (see e.g., Table 3). Hardman and Set (2021) acknowledged that outside learning is essential to students, especially in the Namibian setting and other countries, where science is taught in English as a second language for INSHE students, and cultural aspects can diminish students to be their authentic self in expressing themselves in class due to the teacher presences who are superior to them; therefore, IBSF improves learners' ability to comprehend science learning skills.

## Conclusion

In a constantly changing, increasingly complex educational world, our students need to acquire skills to solve real-life problems through education, such as communicating and managing information to make informed decisions. Thus, in this paper, we concluded that students positively perceive learning skills in IBSF but perceived negatively after over TCA, which means IBSF should be exercised more at the primary stage for students to acquire the science skills that cannot be obtained via TCA. Furthermore, there is a significant difference in the perception of students' learning skills in science whereby after TCA is negatively perceived and after IBSF positively perceived. Furthermore, the is a statistically significant difference how students perceive science learning skills after studying science by teacher centered approach and after IBSF. This indicates that students may experience different science learning skills in different approaches. Teachers need to take this into account when choosing activities in teaching science. It seems that IBSF, which often is conducted in out of classroom environment provides opportunities to learn variety of science learning skills positively, which indicates that students' learning skills play an essential role in the teaching approaches at the primary level. Finally, teaching out-of-classroom environments requires students be involved in experiencing first-hand activities, which is necessary to develop students' skills.

## Recommendations

The study proposes the following elaborations to precisely meet the current trends of science education: the teacher's role is to scaffold students' active participation in science lessons to incorporate the elements of knowledge and understanding through different skills. Furthermore, the content and learning skills should be created to enrich and improve students' abilities and capabilities at the primary level. The assessments need to be redesigned as tools to support students learning. The sample size of this study was relatively small, especially for IBSF. However, the purposive sampling phase of the research inspired us to capture reasonable results from both TCA and IBSF, increasing the validity of the findings and inspiring reliable data (Neuendorf, 2016). However, the modified instrument allowed us to capture reasonable possible results from primary science students. This study is solely based on students and provides only the students' perspective. To capture more precise understanding of the learning process, it would have been informative to include teachers to get a broader view of learning skills in science education and how to strengthen the skills that science learning aims This study is solely based on students, which is a limitation because it would have been informative to include teachers to get a broader view of students' perception of learning skills in science education and strengthen the skills that students lack.

Further studies are recommended to conduct observations and interviews with teachers and students to strengthen the research findings. Different teaching approaches promote different learning skills and allow teachers to gain fieldwork experience and the best way to teach, which is sometimes very individual. Furthermore, it is not only perceptions of learning skills that can be examined separately but also include relations of perception of learning skills to each other. Additionally, our study's results gave a hint about Namibian students' science learning skills in the two approaches, showing students science learning skills after experiencing the approaches. Therefore, we assume two reasons that may explain this outcome. First, Namibian classrooms are crowded, so the teacher cannot pay attention to every student (Ngololo, 2022). Secondly, the primary science curriculum is congested, which causes teachers to only teach students to pass the examination but not grasp the science learning skills (Potokri & Mwelitondola, 2022), henceforth overcrowded classes and congested curriculum negatively impact students' learning especially in TCA which cause students to perform negatively. The results in this study have been limited to public schools, so further research could look at how students in private schools perceive science learning skills in science education. The results of the current study will inform students to use different learning skills in science education and be able to apply them in their daily lives or in other subjects to reinforce and boost the quality of the education system. It will also inform educators in science education about the necessity of IBSF and strengthen their professional development in science education take IBSF more considerably in future.

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## Appendix 1. Students' Responses to the Perception of Science Learning Skills Statements in TCA and IBSF

| | Strongly agree | | Agree | | Neutral | | Disagree | | Strongly disagree | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Statements** | **TCA** | **IBSF** | **TCA** | **IBSF** | **TCA** | **IBSF** | **TCA** | **IBSF** | **TCA** | **IBSF** |
| **MS-** can help me to learn time management | 4 | 24 | 4 | 48 | 24 | 26 | 86 | 1 | 20 | 1 |
| **MS** -can help me to judge myself more clearly | 5 | 29 | 4 | 51 | 25 | 18 | 79 | 2 | 24 | 0 |
| **MS** -can help me set goals in my life | 6 | 28 | 8 | 59 | 38 | 12 | 61 | 1 | 24 | 0 |
| **MS** -can help me to view issues from a different perspective | 3 | 41 | 17 | 50 | 47 | 7 | 50 | 2 | 20 | 0 |
| **LS**- can teach me cooperation skills | 4 | 36 | 2 | 49 | 43 | 13 | 67 | 2 | 21 | 0 |
| **LS**-can teach me independence | 4 | 37 | 3 | 49 | 44 | 13 | 67 | 1 | 19 | 0 |
| **LS**- can teach me to be a team player | 3 | 28 | 15 | 63 | 48 | 7 | 48 | 2 | 23 | 0 |
| **IS-**can enhance my skills in data recording | 2 | 31 | 6 | 59 | 42 | 10 | 63 | 0 | 24 | 0 |
| **IS** -can enhance my skills in information handling | 5 | 32 | 4 | 55 | 43 | 12 | 61 | 1 | 24 | 0 |
| **IS** -can enhance my skills in information retrieval | 3 | 23 | 9 | 56 | 41 | 18 | 60 | 3 | 26 | 0 |
| **TS**- can assist me in learning to negotiate | 6 | 41 | 5 | 50 | 52 | 8 | 53 | 1 | 21 | 0 |
| **TS**- can assist me in taking responsibility | 6 | 21 | 3 | 54 | 31 | 22 | 70 | 3 | 27 | 0 |
| **TS**- can assist me in learning how to take initiative | 2 | 29 | 13 | 61 | 47 | 9 | 57 | 1 | 18 | 0 |

| | Strongly agree | | Agree | | Neutral | | Disagree | | Strongly disagree | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Statements** | **TCA** | **IBSF** | **TCA** | **IBSF** | **TCA** | **IBSF** | **TCA** | **IBSF** | **TCA** | **IBSF** |
| **TS** – can assist me in learning to discuss | 4 | 39 | 12 | 53 | 57 | 8 | 39 | 0 | 25 | 0 |
| **PSS**- can expand my thinking ability | 6 | 28 | 13 | 61 | 41 | 10 | 57 | 1 | 20 | 0 |
| **PSS**- can help me learn how to set questions clearly | 4 | 28 | 11 | 58 | 54 | 13 | 50 | 1 | 18 | 0 |
| **PSS -** can teach me to learn differently | 5 | 30 | 14 | 53 | 44 | 15 | 52 | 2 | 22 | 0 |
| **CS-** can sharpen my reading | 6 | 22 | 2 | 54 | 35 | 21 | 68 | 3 | 26 | 0 |
| **CS-** can sharpen my listening skills | 3 | 26 | 10 | 50 | 40 | 22 | 62 | 2 | 22 | 0 |
| **CS-** can help me utilize effective peer-evaluation | 2 | 33 | 13 | 50 | 51 | 16 | 53 | 1 | 18 | 0 |
| **IqS-** can teach me to design field-based investigations | 1 | 26 | 7 | 48 | 25 | 25 | 79 | 1 | 25 | 0 |
| **IqS-** can help me to solve problems | 2 | 32 | 8 | 55 | 47 | 13 | 57 | 0 | 23 | 0 |
| **IqS-** can enhance my interpretation skills | 1 | 25 | 9 | 54 | 40 | 20 | 69 | 1 | 18 | 0 |

## Appendix 2. Content and Aims of the Lessons taught to Students in TCA and IBSF Groups

| Lesson | Content of the lessons | Aims of the lessons |
|---|---|---|
| **Plants** | -Identify the structure of a flowering and non-flowering plant (take pictures).<br>-Describe the difference and similarities between flowering and non-flowering plants.<br>-Describe the species of different plants.<br>(Make use of small plants to identify the flowers, leaves, fibrous and tap roots). | - To understand the structure of flowering and non-flowering plants.<br>- To understand the differences and similarities of flowering plants.<br>-Describe the species of plants. |
| **Animals** | -Explain the physical difference between amphibians and reptiles.<br>-Describe in your own words the living environment of the butterfly and what it is doing.<br>-Describe how animals are adapted the environment for survival. | - Understand the physical difference between amphibians and reptiles.<br>-Describe the living environment of the butterfly.<br>-To understand how animals are adapted to the environment. |
| **Ecosystem** | -Define the term Ecosystem<br>-Describe the energy flow of living organisms within the Savannah Ecosystem.<br>-Describe how birds are adapted to the environment for survival.<br>- Construct a food chain using organisms in your environment. | - To gain knowledge of the Ecosystem.<br>-Understand the flow of energy in the Ecosystem.<br>- To understand how birds are adapted to the environment.<br>-Construct a food chain |

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The lessons in IBSF were conducted in the savannah ecosystem, and students spent two-three hours in the field. Two teachers supervised IBSF, which had 5-6 learners per group, compared to TCA lessons conducted in the classroom, one lesson was 45 minutes, and each student was seated individually at his/ her desk. Both groups had double lessons for each topic.