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Sway-Based Interactive Chemistry Learning Media: Feasibility for Improving Students' Conceptual Understanding and Self-efficacy

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Abstract: Self-efficacy greatly determines the success of students in learning. However, most students have low self-efficacy. This study aims to develop sway-based interactive chemistry learning media to improve the students' conceptual understanding of stoichiometry and self-efficacy. The research used a 4D development model which consists of the stages of define, design, develope, and disseminate. Sway-based media trials include individual trials involving 3 students, small group trials involving 8 students, and field trials involving 2 classes consisting of 70 students of class X MIPA SMA Negeri 4 Banjarmasin. The study indicated that the developed sway-based media: (1) very valid from the aspect of content, presentation, language, and media; (2) practical based on one to one and small group trials, students' responses, and learning process management data; and (3) effective based on the N-gain score of the students' conceptual understanding of stoichiometric concept and self-efficacy in the medium and high categories, respectively. It can be concluded that sway-based interactive learning media is feasible used in chemistry learning to improve students' conceptual understanding of stoichiometric concepts and self-efficacy.

Keywords: Conceptual understanding; Self-efficacy; Stoichiometry; Sway-based learning media

Introduction

Self-efficacy is the result of cognitive processes in the form of decisions, beliefs, or expectations about the extent to which individuals estimate their ability to carry out their duties or certain actions required to achieve the desired result (Nuzulia, 2010). Academic self-efficacy is defined as a belief in individuals on their ability to perform tasks, and organize their learning activities, for realizing good academic expectations of themselves and other people (Lidya et al., 2015). Student self-efficacy and academic achievement are mutually associated (Nzomo et al., 2023; Olivier et al., 2019). Then students who have high self-efficacy will believe that they can master tasks and regulate their way of learning, they are the ones who are most likely to achieve good performance in school (Papalia et al., 2009). Students with high self-efficacy tend to set mastery goals, do more challenging tasks, and obtain better grades (Schnell et al., 2015). So, they will be able to choose productive, directed, and planned actions to achieve optimal mastery of concepts (Hardianto et al., 2016).

A preliminary study in class X MIA 2 MAN 3 Banjarmasin showed that the students' self-efficacy showed 37.94% classified as lacking and 62.02% of students classified as high (Kusasi et al., 2020). The level of students' academic self-efficacy in class X SMA Kesatrian 1 Semarang of 243 students' obtained 67 students' (27.57%) in the low category, 49 students (20.16%) students in the medium category, and 127 students (52.26%) in the high category. In other words, at SMA Kesatrian 1 Semarang (Setiawan, 2015).

Utami et al. (2017) found that educators in learning process rarely give non-routine problems because, in the learning process, most students only remember not to understand concepts. Consequently, they are confused when connecting the information presented in the problem with concepts that can be used to solve the problem. Most of them are concerned with the final answer compared to the process of solving the problem,

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especially if the questions given are different from the examples. It has caused students' insecurity in solving problems. When they find things they don't understand, students show more silence and don't dare to ask questions. This situation has an impact on the low of their self-efficacy.

The students' self-efficacy learning increased for some students who have good information technology (IT) skills and have adequate supporting facilities, but for participants who are less familiar with technology, it does not have much effect. The self-efficacy of students who receive the e-learning model increased as the self-efficacy of students who receive conventional learning (Wahyudin et al., 2019). Yuniarti et al. (2015) state that students' mastery of concepts can increase by manipulating the objects they see and hear through video media. In this way, students actively acquire knowledges and apply them, which is difficult to achieve in real classes.

It is necessary to have innovative learning media that can make the learning process better and increase students' conceptual understanding including chemistry and self-efficacy. The use of android learning media has a significant effect on students' self-efficacy in learning chemistry. Chen (2014) reported that students who use technology in learning have high self-efficacy and accept the existence of technology-based learning media. so In this case, android-based learning media can be used as effective and efficient media in improving the self-efficacy of learners. Fitriyana et al. (2018) found that using technology-based learning media in learning makes students easier to understand the learning material so that their self-efficacy becomes better.

One of the technologies that can be utilized by educators is sway-based online learning media. *Sway* is an application from Microsoft Office that can be used to collect, format, and share ideas, stories, and presentations on a web-based interactive canvas. We can easily add text, images, documents, videos, charts, or other types of content to your sway. Sway can be accessed from various devices as long as they are connected to the internet. The sway-based online learning media developed can be accessed by students via smartphones, tablets, or laptops/computers. Thus, learning can continue without being limited by space and time. Sway-based online learning media can also be a solution to various students' problems in the current digital era. The habit of students' accessing online games and other non-educational sites can be transferred to learning by using sway-based online learning media. Thus, we can overcome various negative impacts of technological and information developments (Dwianto, 2019).

Learning that uses sway-based media has excellent design features to make it easier for users to upload various content such as videos from youtube, pictures, tweets, and other multimedia content. Sway-based media can also choose content such as photos and videos that are stored in the cloud because Sway is connected to the cloud. Sway-based media will reformat presentation slides when the presenter opens them via a smartphone, laptop, or PC and is equipped with an application to make it easier for users to collaborate with other users in creating sway projects (Astuti, 2020).

Several studies have been conducted related to the development of sway-learning media to improve students' knowledge and self-efficacy in learning outcomes, such as the research conducted by Sudarmoyo (2018) states that the developed sway-based media make students more confident and support the success of the learning program. Research conducted by Ardian et al. (2020) states that sway-based learning media can be a solution during a pandemic where educators must create attractive online learning media so that students can be interested even though they are not face-to-face in real class.

Research by Astuti (2020) states that sway-based learning media applied to Information and Communication Technology (ICT) subjects can make students understand the basics of internet networks and increase students' enthusiasm for learning in learning. Meanwhile, here the researcher wants to apply sway-based interactive learning media to improve students' mastery of stoichiometric concepts and self-efficacy in learning.

The use of the sway program can be an alternative way for developing an interactive chemistry learning media. This study tested the feasibility (validity, practicality, effectivity) of the sway-based media to improve the students' conceptual understanding of stoichiometric concept and self-efficacy.

Method

This research applied Research and Development (R&D) design with 4D models. The research was conducted at SMA Negeri 4 Banjarmasin during 4 weeks involving students of class X MIPA. The trial subjects were determined using cluster random sampling. Because the class division in the school was divided equally in terms of the cognitive abilities of students. The research phases of 4D include define, design, develope, and disseminate as Figure 1.

In the define stage, researcher determined and define the development requirements that aim to collect various information related to the product of sway-based stoichiometric chemistry learning media. The researcher also conducted front-end, students, assignments, concepts, and learning objectives analysis. Next, at the design stage, it was carried out designing the content framework and outline of a sway-based learning media product on the stoichiometric material to be developed. There are 3 activities in this stage namely the preparation of tests, media selection, and instructional media design. In the development stage researcher conducted, (1) product validation by experts; (2) one to one trial on three students; (3) a small group trial conducted on 8 students; (4) a field trial conducted in class X MIPA 2 and MIPA 4 SMA Negeri 4 Banjarmasin involving 70 students.

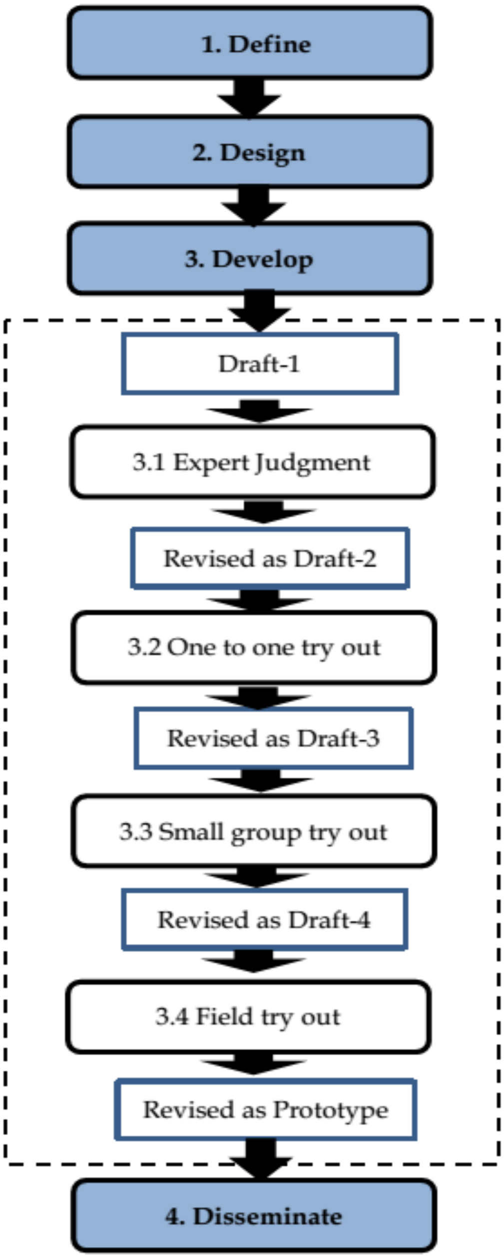

Figure 1. The research phases

The validity of the sway-based media instrument was made in the form of a structured questionnaire based on aspects of content, presentation, language, and media feasibility. Meanwhile, an unstructured questionnaire used to provide criticism and suggestions to improve the validity of learning media. The practicality assessment instruments was in the form of a readability questionnaire, a students' response questionnaire, and the practicality of media for educators during learning process. The effectiveness assessment instrument consists of conceptual understanding of stoichiometric concepts test and self-efficacy test instruments.

The validity of the test instrument of stoichiometric concept and self-efficacy of students were obtained from experts' ratings, which then matched to Aiken's V scale as presented in Table 1.

Table 1. Validity Scoring Criteria Based on Aiken's V Scale (Retnawati, 2016)

Aiken's V scale	Validity
$V \leq 0.40$	Poor
$0.40 < V \leq 0.80$	Moderate
$0.80 < V$	Valid

The reliability of the test instrument is in the form of multiple choice questions using the Kuder and Richardson formula, namely the KR-20 (Jihad et al., 2013). The test instrument of the knowledge learning outcomes has a reliability coefficient of 0.66 or the medium category.

The difficulty level of the conceptual understanding test instrument of the 10 questions tested, there were 4 questions in the easy category, 5 questions in the medium category, and 1 question in the difficult category. Meanwhile, their discriminatory power there were 1 question with poor discriminating power, 5 questions with sufficient discriminating power, 3 questions with good discriminating power, and 1 question with excellent discriminating power.

The data of sway-based learning media trial were then analysed to determine its validity, practicality, and effectiveness. The analysis of the validity of the sway-based learning media used criteria as presented in Table 2.

Table 2. The Validity Criteria of Media (Akbar, 2013)

Score	Category	Description
86 – 100	Very valid	No revision needed
71 – 85	Valid	Minor revision
51 – 70	Not valid	Big revision
0 – 50	Invalid	Total revision

The practicality analysis was carried out using a readability test where the readability test is divided into individual readability and small group readability. Practicality is not only seen from readability, it was also seen from the responses of students and the practicality of media for educators to use media and manage the learning process. The criteria of learning media practicality is presented in Table 3.

Table 3. The Practicality Criteria of Media (Widoyoko, 2016)

Score	Category
4.21 – 5.00	Very good
3.41 – 4.20	Good
2.61 – 3.40	Moderate
1.81 – 2.60	Poor
1.00 – 1.80	Very poor

Analysis of the media effectiveness was obtained from the N-gain of students' conceptual understanding and self-efficacy (Table 6). Meanwhile the criteria of conceptual understanding and self-efficacy score was pesented in Table 4 and Table 5 respectively.

Table 4. The Category of Pre-Test and Post-Test Assessment Criteria for Mastery of Students' Stoichiometric Concepts (Sudjana, 2014)

Range	Category
81 – 100	Very high
61 – 80	High
41 – 60	Moderate
21 – 40	Low
0 – 20	Very low

Table 5. The Category of Pre-Test and Post-Test Assessment Criteria for Students' Self-Efficacy (Widoyoko, 2016)

Range	Category
85 - 100	Very high
69 - 84	High
53 - 68	Moderate
37 - 52	Low
20 - 36	Very low

Then, the N-gain of students' conceptual mastery and self-efficacy were categorized in Table 6.

Table 6. N-gain Criteria (Hake, 1999)

N-gain	Category
$(g) < 0.30$	Low
$0.30 < (g) < 0.70$	Moderate
$(g) > 0.70$	High

Result and Discussion

Result

The research product that has been developed was the sway-based chemistry learning media to improve students' conceptual understanding of stoichiometric concepts and self-efficacy. In this case, students were invited to learn by using a new ways in studying chemistry using a creative and innovative learning media. The learning media was designed based on the STAD (student team achievement division) type of cooperative learning model and problem-solving learning to makes easier for students to learn. The systematics of sway-based media preparation as presented in Table 7.

Table 7. Systematics of Sway-Based Media

No	Components
1	Front cover page consists of material title, meeting description, class identity, subject educator identity and author identity.
2	The start/home page consists of learning objectives
3	The content page consists of learning materials regarding stoichiometric material presented in the form of text, images, animations, and sample questions
4	The last/end page of the closing words is thank you

Validity of Sway-Based Media

The validation of sway-based learning media was carried out by the 5 validators before the field trial. Validation data of learning media were briefly presented in Table 8.

Table 8. Validity Data of Learning Media

Validty Aspect	Validity Value	Description
Contents	82.29	Valid
Presentation	88.00	Very valid
Language	89.85	Very valid
Media	89.50	Very valid
Average	87.41	Very valid

Based on Table 8, the sway-based chemistry learning media was very valid to be used to improve students' conceptual understanding of stoichiometric concepts and self-efficacy.

The practicality of Sway-Based Media

Practicality of learning media was carried out by providing readability questionnaires, response questionnaires to students' and practicality of media for educators. The readability data of learning media were collected from one to one and small group trials as presented in Figure 2.

Readability statements,

1. The cover design is attractive and describes the contents inside.
2. The pictures in the learning media are interesting and in accordance with the material being studied.
3. The images presented in this learning media are visually beautiful and clear.
4. The writing in learning media uses clear letters, combinations of letters, colors, and pictures are harmonious.
5. The sentences in learning media are easy to understand and communicative.
6. The pictures are clearly visible in the learning media and their meaning is easy to understand.
7. The terms in learning media are easy to understand.

8. The material presented in the learning media is coherent.
9. The sentences in this learning media do not cause double meanings.
10. The exercises, independent assignments and formative tests in learning media can be understood and answered easily.

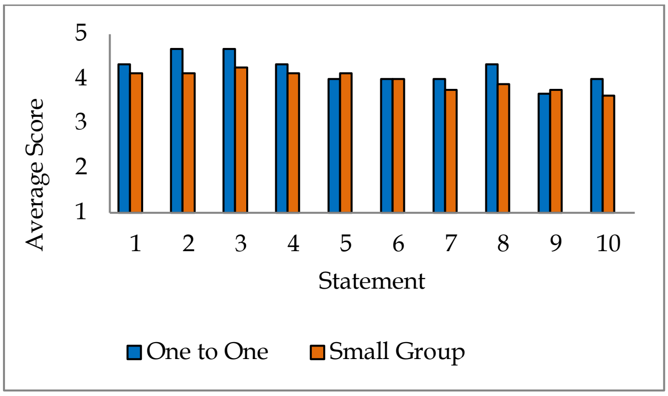

Figure 2. The readability data of learning media from one to one and small group trial

Based on Figure 2, the average score of readability of learning media in one to one and small group trial is 4.20 and 3.98 or good category, respectively. These data indicate that the developed learning media can be tested in the next stage.

The response questionnaire was given after the students did the post-test and after the field tryout was completed. Students' responses were carried out on 70 students' of class X MIPA 2 and MIPA 4 SMA Negeri 4 Banjarmasin. The average score of student's response in both classes is 3.88 and 4.06 respectively, which were included in the good category. The students' response to the learning media in field trial as presented in Figure 3.

Student's response statements
1. Learning stoichiometry material using "Sway-based chemistry learning media on stoichiometry material"(Learning media) makes me have a high willingness to take part in lesson activities.
2. The learning media made me easier for me to understand stoichiometry material clearly and in an attractive appearance.
3. The learning media made me easier to solve stoichiometry problems.
4. The learning media made me not feel bored in the learning process in class because it is equipped with pictures or illustrations.
5. The learning media made me motivated to solve problems presented in the form of questions through group discussions.
6. The learning media made me independent and active in solving problems.
7. The learning media fostered interaction between me and educators and group mates.
8. The learning media grew my awareness in the process of thinking to solve problems.
9. The learning media gave me more knowledge about technology.
10. The learning media made me happy to study stoichiometry because it can provide more knowledge because it is related to everyday life.

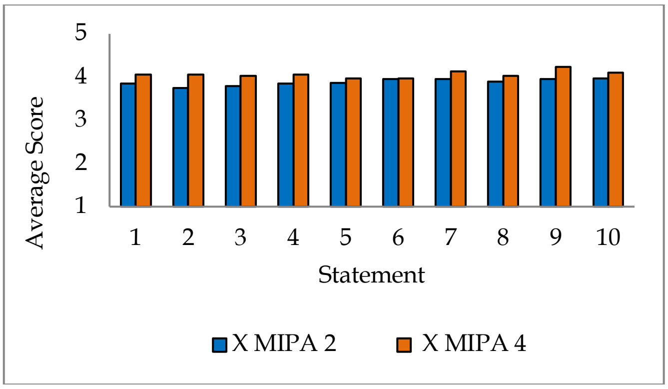

Figure 3. The student's response to the learning media in field trial

The practicality of learning media for educators is measured by using observation sheet. The average score of learning media practicality for educators using learning media in the field trial is 4.37 or very good category (Figure 4).

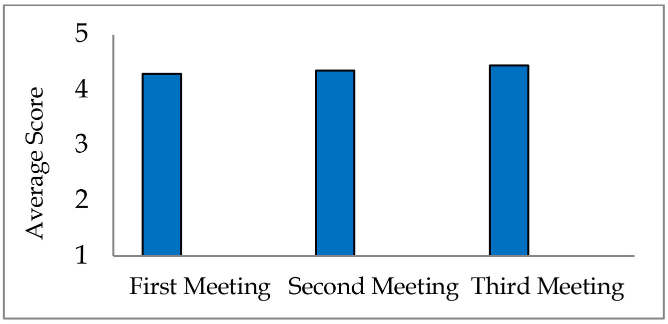

Figure 4. Media practicality scores for educators in managing the learning process

Based on the data obtained from the students' response questionnaire and the practicality of the media for educators, it can be concluded that the learning media developed is practical.

Effectiveness of Sway-Based Media

The effectiveness data of learning media was obtained from the analysis of conceptual understanding of stoichiometric concepts and students' self-efficacy in the field trial. The average score of the pre-test and post-test of students' conceptual understanding of stoichiometric concepts in moderate and good category respectively (Figure 5).

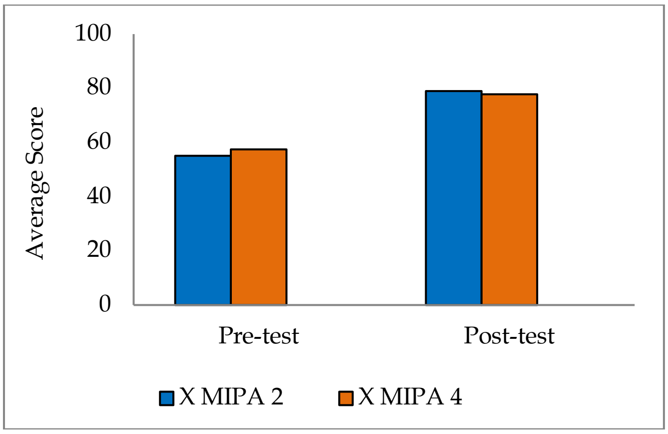

Figure 5. Average pre-test and post-test scores of students' conceptual understanding of stoichiometric concepts

Figure 5 showed that students' conceptual understanding of stoichiometric concepts from pre-test to post-test. The average N-gain score obtained in both class is 0.54 and 0.49, respectively. Both of them were included in the medium category.

Students' self-efficacy data was also determined by pre-test and post-test scores. Students' self-efficacy also increase that shows the effectiveness of learning media. The average score of students' self-efficacy can be seen in Figure 6.

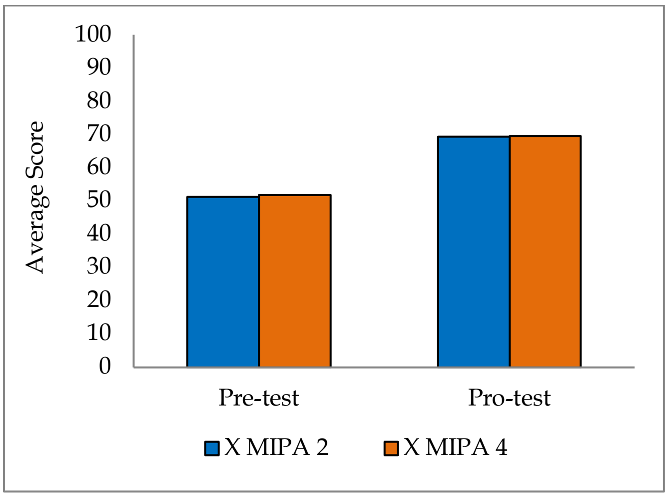

Figure 6. Average pre-test and post-test scores of students' self-efficacy

Increasing of students' self-efficacy was indicated by the average of N-gain score obtained by both classes of 0.77 or high category. These results illustrate the effectiveness of learning media on the affective development of students.

Discussion

According to experts' ratings, the validity of the sway-based chemistry learning media include validation aspects of content, presentation, language, and media, that were categorized as very valid (Table 8). It means that this media is very valid to be used to increase students' conceptual understanding of stoichiometric concepts and self-efficacy. The display of the developed media as presented in Figure 7.

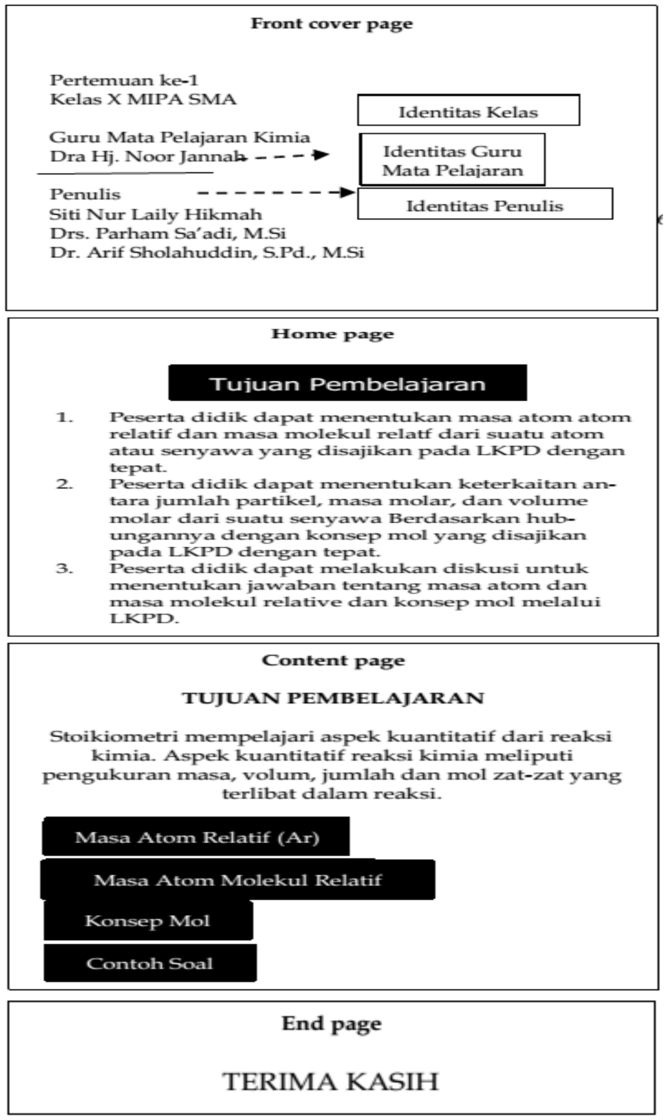

Figure 7. Display sway-based media

The practicality data of the learning media developed were obtained through a readability questionnaire and a student response questionnaire. In addition, practicality data was also obtained through the practicality of media for educators in using learning media and managing the learning process filled by observers. Based on one to one and small-group readability trials (Figure 2), the results were categorized as good. This indicates that the developed product can be used at the next stage by considering the observer's rating and suggestions. Zubaidah et al. (2016) also conducted a practicality test using a readability questionnaire aims to obtain readability information and as a consideration for determining whether or not the learning media being tested is good. This research also found that the students' responses to the sway-based media were good category (Figure 3). According to Wona et al. (2022), these results cannot be separated from the influence of the learning media used, where the learning media developed can help students more easily understand the material.

The practicality of aq the sway-based media can also be seen from the practicality of the media for educator in managing the learning process was in the very good category (Figure 4). Based on the score in Figure 4 given by the observer at the first meeting, it became the lowest score among the three meetings. This is because the involved educator and students in this study need to adaptation in using a new learning media. This was supported by Faizah et al. (2013) that if students are not familiar with the learning components, it will take time to adapt to these learning components. Based on the data obtained from the response questionnaire and the practicality of the media for educators, it can be concluded that the learning media developed has fulfilled the practicality aspect.

The effectiveness data of developed learning media were obtained from the analysis of students' conceptual understanding of stoichiometric concept and self-efficacy, namely the N-gain results from pre-test and post-test data carried out in field trials. This research found that the students' conceptual understanding of stoichiometric concepts in both participating class showed an increase (Figure 5). This is indicated by the average N-gain score obtained which is included in the medium category. The pre-test scores obtained which are moderate category. It indicate that students are already active in learning knowledge before the implementation of the learning process. Astuti (2020) stated that the sway learning media developed at SMP Negeri 3 Probolinggo can create a more conducive and meaningful learning atmosphere to increase students' passion for learning. Yuliani et al. (2017) also state that learning media has a positive effect on students' learning motivation, which means that if the level of use of learning media decreases or is less, the level of learning motivation will decrease. Thus, every increase in learning media will be followed by an increase in learning motivation. Learning media can also affect students' mastery of concepts through learning motivation. Poernamasari et al. (2022) also found that microsoft sway-based interactive multimedia improved student learning outcome and motivation.

Based on the self-efficacy questionnaire data of students in both participating class also showed an increase (Figure 6). This is indicated by the average N-gain score obtained which is included in the high category. These results illustrate the effectiveness of learning media on increase students' self-efficacy. Sudarmoyo (2018) states that the developed sway-based media can make students more confident and can support the success of the learning program. Because, self-efficacy has been consistently linked to positive outcomes such as increased engagement and performance (Power et al., 2020). Online learning self-efficacy (and academic emotions as enjoyment; boredom) mediated the link between interactions (learner-content interaction and learner-learner interaction) and learning engagement (Wang et al., 2022). Someone who have strong self-efficacy in learning or doing tasks tend to be more competent and can participate easily, work harder, can survive when they face difficulties, and can reach higher levels (Alhadabi et al., 2020; Baanu et al., 2016).

Online-based learning media that were integrated with inquiry/problem-solving learning models and assisted learning management systems have been proven to be able to improve chemistry and physical learning outcomes, especially during a pandemic (Darby-White et al., 2019; DeMatteo, 2019; Masril et al., 2018; Syafei et al., 2022). Ardian et al. (2020) also reported that sway-based learning media can be an alternative solution during a pandemic where educators must create interesting online learning media so that students can be interested even though they are not face-to-face.

The disadvantage of this sway-based media is that it requires the internet to access it. In addition, the sway-based media does not support features for writing chemical symbols or formulas, so some writings are not following the rules for writing symbols or actual chemical formulas. Constraints faced in online learning are signal constraints and network strength which are not evenly distributed in each region, along with other obstacles, namely wasteful internet quotas that burden financing, as a result, some of the students cannot understand the learning materials properly. In fact, for students, the explanation of the teacher, both in theoretical and practical material, is needed to avoid misconceptions between students and educators.

The learning environment is also an obstacle for students, currently, students learn from their respective homes. This causes a lack of focus when learning takes place, sometimes students forget the lesson schedule that has been given because they have fallen asleep, and some need to help their parents before learning begins. Several obstacles were also experienced by educators especially relate to the unstable signal and internet network. Likewise regarding time efficiency, learning in this pandemic period requires more time to prepare for learning because it has to upload teaching materials and provide some direction to students' before the learning process takes place.

Although there are many obstacles faced in the implementation of online learning, it is still considered quite good. Because when viewed from the students' conceptual understanding of stoichiometry concepts and self-efficacy, there is a consistent increase in every implementation of online learning. However, certain things such as those complained of by students and educators must be addressed so that learning is more optimal.

Conclusion

The sway-based interactive chemistry learning media created by researchers can be used as a constructivist learning resource to improve students' conceptual understanding of stoichiometric concepts and self-efficacy. The study found that the learning media developed was 1). Very valid based on a feasibility test by a group of experts who are included in the very valid category; 2). Practical based on individual and small group readability tests, and students' responses, educators use learning media and manage the learning process; 3). Effective because there is an increase in the mastery of the stoichiometric concept and self-efficacy of students in field tryouts with N-gain minimally in the moderate category. Based on the research findings several recommendations need to be considered to improve the quality of the media and learning 1). Students can maximize devices such as PCs/laptops to support learning activities, so they can use them for good learning activities in class and at home; 2). Educators can develop this sway-based media with a wider scope or in other chemistry materials, to provide good benefits for learning; 3). Further research on sway-based learning media needs to be carried out by involving a wide research subject.

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